October, 1978
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# Technology Review

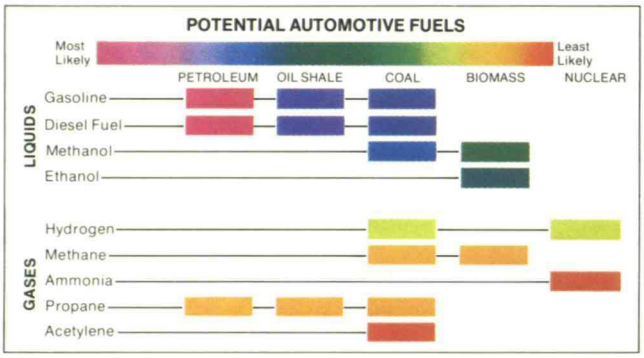
Edited at the Massachusetts Institute of Technology

## The Computation of Vision: What the Brain Solves When We See

technology
review
Published by MIT

By the end of this century, when the world's demand for petroleum will exceed what it can produce, alternative fuels will have already begun phasing into the energy picture.

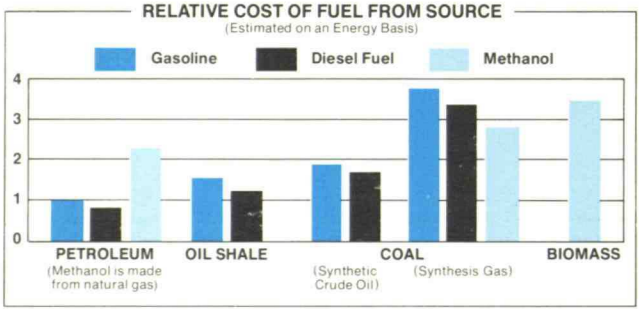
What will these new fuels be? Scientists here at the General Motors Research Laboratories long ago started exploring the possibilities. They've conducted engine studies with hydrogen, methane, ammonia, propane, acetylene, methanol, ethanol, and with liquid hydrocarbons from coal and oil shale.




Although the principal aim was to understand the combustion process, the overall system — from resources in the ground to power at the wheels — was also considered.

So what have we learned? Hydrogen, for example, behaves well enough in an engine. However, storage and control problems in a car severely limit its prospects.

Methanol, on the other hand, is more manageable. And we have modified production vehicles to run on this fuel. But methanol poses a serious starting difficulty below 5° C. Moreover, it would be costly.




Which brings us to gasoline and diesel fuel derived from oil shale. Environmental, social, and political factors may favor other alternatives. But our studies, based on energy efficiency and economics, indicate that these two derivatives have the greatest potential for being the automotive fuels of tomorrow.

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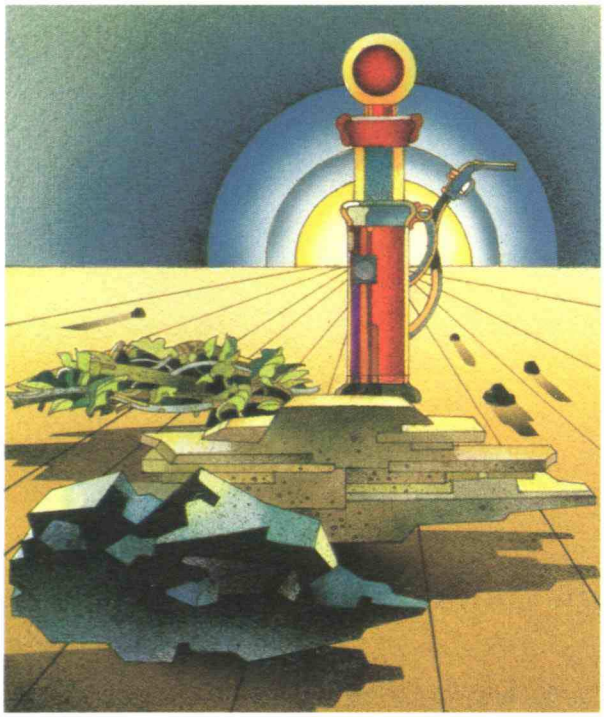
# There's no fuel like the old fuel. But there are alternatives.



GM

**General Motors Research Laboratories**
Warren, Michigan 48090

ALUMNI ASSOCIATION
*of the* MASSACHUSETTS INSTITUTE OF TECHNOLOGY
*Cambridge*

To Members of the Classes of 1979 and 1980:

The Alumni Association of M.I.T. is pleased to enroll you as a complimentary subscriber to the student edition of TECHNOLOGY REVIEW and to send you this first issue. The REVIEW is published eight times each year by the Association for 35,000 M.I.T. Alumni and for some 25,000 non-alumni (paying) subscribers; the student edition will be sent to you without charge five times during the current academic year. The REVIEW has a two-fold assignment: to provide for all its subscribers a sense of current issues and developments in technology and related fields; and to provide for alumni continuing contact with the Institute and among themselves.

The rolls of the Alumni Association include 66,000 former students of the Institute. The Association maintains an office and staff in the Alumni Center, on the first floor of the Maclaurin Building (Building 10). An office and smaller staff is also located in New York City. Upon your graduation from M.I.T., the Association will provide the means for continuing involvement with the Institute and contact with your classmates. Through the Association, M.I.T. alumni are active in M.I.T. clubs throughout the world, as workers for the annual Alumni Fund, and as Educational Counselors interviewing prospective M.I.T. students. They serve on numerous committees, trusts, and boards in support of M.I.T. and fellow alumni. They participate in Technology Day, Summer Colleges, Conferences, and special events both on and off the campus. We hope that as a student you will also join us in some of these activities.

Alumni enjoy meeting students as a way of keeping in touch with M.I.T. and because they are sincerely interested in our students' well being. During the year, you may be asked to visit with alumni to share your experiences at M.I.T. and to talk of involvement with the Institute after graduation. We hope you will accept that invitation. Our staff also welcomes the opportunity of working with you on student projects. Please call on them for assistance, and please visit us in the Alumni Center whenever you want to join in alumni activities.

I trust that the TECHNOLOGY REVIEW will serve you well. I send it as a welcome to the Association.

Very truly yours,

Joe F. Moore

Joe F. Moore '52
President
M.I.T. Alumni Association

# "At Du Pont you don't get lost in a big company atmosphere. It's very personal."

—George D. Peterson BS, Chemical Engineering

"Du Pont is a big company but it's broken down into satellites. So you don't get lost in a big-company atmosphere. It's very personal, and I think the people are top-notch.

"I started in technical here at the Belle Plant in West Virginia. Now I'm a production supervisor. Production is solving problems on a day-to-day basis. I like working under that kind of pressure. When things work out, it's very rewarding. So is working with people. I'm responsible for helping 22 people do their jobs."

George was recruited by Du Pont from the Michigan Technological University campus in 1973. He interviewed about 25 companies.

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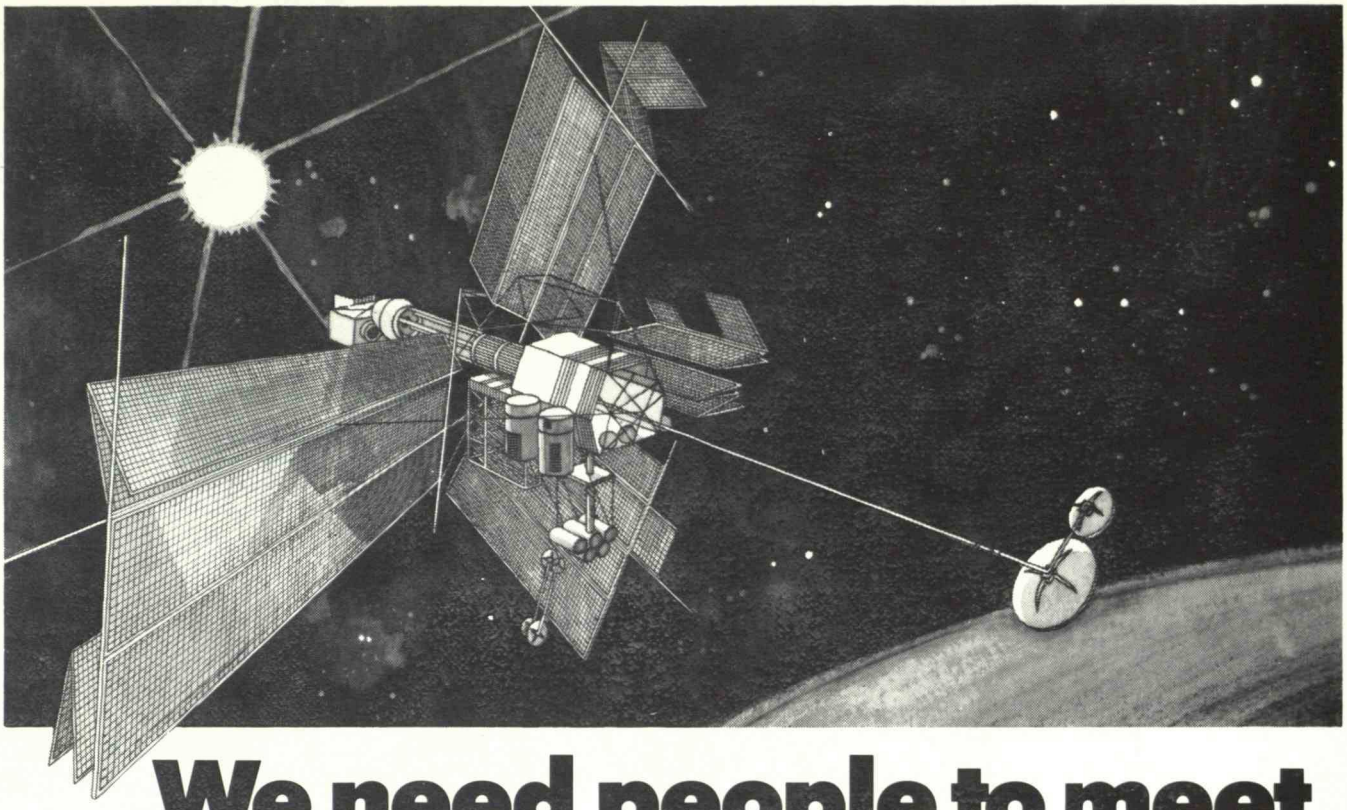

# We need people to meet the challenges of the future.

And some that we already have. In short, we need fine 21st-century minds. Now.

Should immense solar power stations be placed into stationary orbit around our planet, as drawn above? How will we extract oil from shale, yet preserve the environment? How will we transform the heat of the earth into useful energy?

We need people from scores of skills and disciplines. People who are seeking careers in chemical engineering. Computer science. Electrical engineering. Geology. Geophysics, mechanical engineering, mining engineering, petroleum engineering, petroleum land management. And accounting and business administration.

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To perform these challenging tasks, Gulf needs good people.

If you would like to play a part in the solutions, please make an appointment to see one of the Gulf Human Resources representatives who will visit your campus. Or, if you prefer, write Mr. Virgil Hanson, Human Resources Department, P.O. Box 1166, Pittsburgh, Pa. 15230.

It could be very rewarding to join the Gulf people who are meeting the challenge.

Gulf

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2. *Steve O.* Design engineering. Design test equipment for attitude control system of new communications satellite.
3. *Norma L.* Steam-turbine manufacturing. Investigate, analyze and obtain funds for solution of shop problems.
4. *Stephanie B.* Medical systems service engineering. Installation and test of new hospital radiographic and fluoroscopic x-ray system.
5. *Mel D.* Field engineering. Appraisal load testing of low and medium-voltage switchgear and power transformers for utility and industrial applications.

There's a good reason GE hands people like that – like you – real work assignments. It's the best way to develop the skills you will need throughout your career. You develop initiative and creativity. And responsibility. And GE also knows there's little to match the glow you feel when you make an important contribution.

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Progress for People

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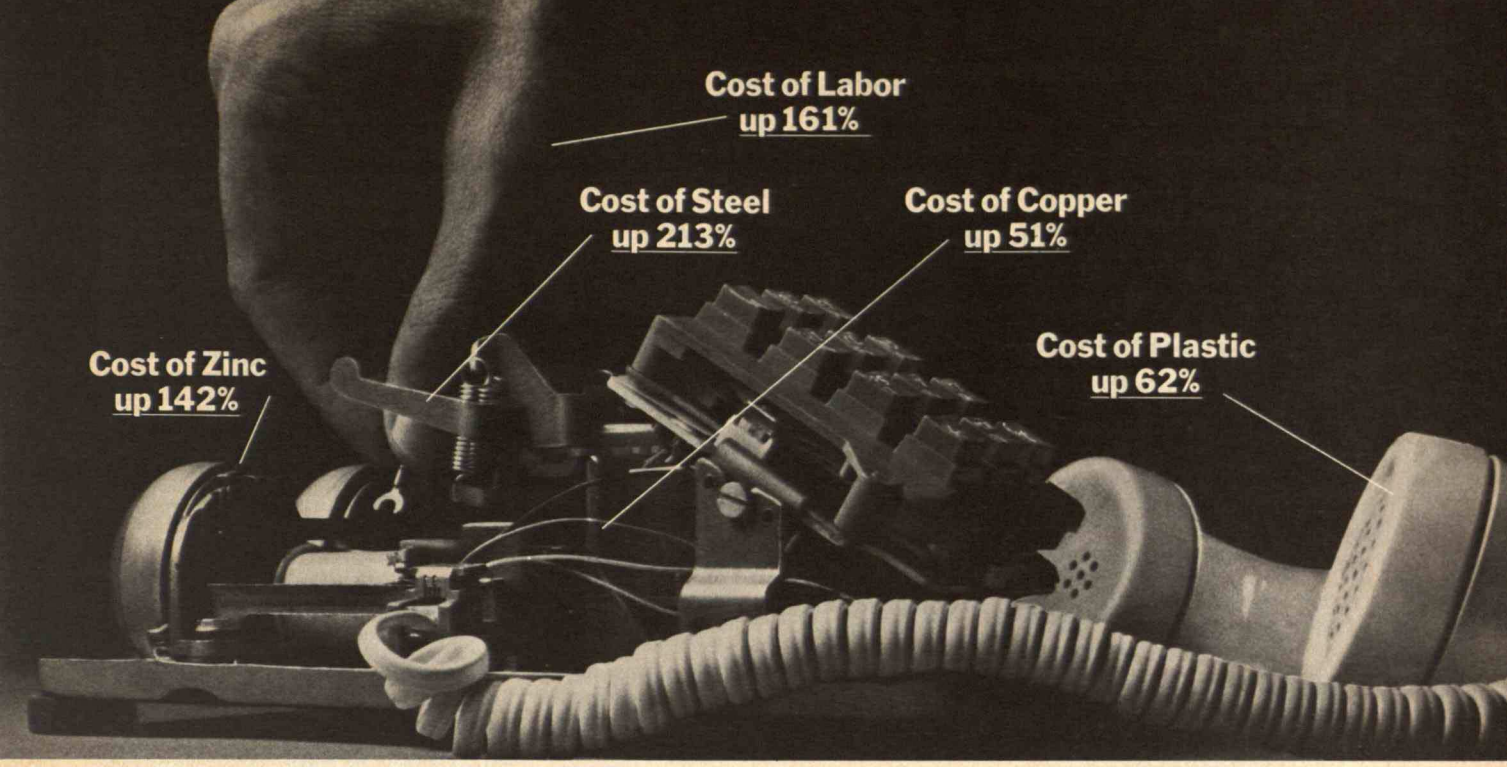


# How come when we put it all together, it's only up 18%?

In the last 10 years, the costs of labor and raw materials that go into this telephone have skyrocketed. And yet, the price of the finished product has risen only 18%.

## Making it Better.

The explanation is really quite simple. During the same period of time, this telephone has been redesigned literally dozens of times. Western Electric engineers kept discovering ways to make it a little more efficiently. So while our materials and labor costs were going up, we've been able to hold our manufacturing costs down. Not a bad way to cope with inflation.

At Western Electric, cost reduction and other improvements in our productivity don't just happen. They're the result of a systematic and formalized program which has existed for years.

One of the key elements in this program is our Engineering Research Center (ERC). Western Electric is one of the few corporations that has such a facility.

Unlike most research and development centers, its primary purpose is *manufacturing* research.

Working closely with Bell Labs, where most of our products are designed, the ERC has developed new manufacturing processes that have resulted in enormous savings for Western Electric and the Bell telephone companies.

## Committed to Cutting Costs.

In the last few years, Western Electric has implemented over 10,000 different ideas to cut costs.

Like the idea developed by two of our engineers to redesign a piece of casing. In its first year it saved $2.3 million.

Or like the idea developed by a team of engineers from Western Electric and Bell Labs that involved a new technique for electroplating our switching equipment. It has saved over $8.5 million in its first year.

In 1977, the net effect of our cost reduction program was a savings of over $200,000,000.

## Continuing Innovation.

With cost reductions like these, no wonder our rate of productivity improvement is well ahead of the overall U.S. rate. And it's one reason that during the past 10 years, telephone rates have risen less than half as fast as the consumer price index.

It's a reflection of our continuing innovation and the close collaboration of Western Electric, Bell Labs, and Bell System telephone companies.

*Keeping your communications system the best in the world.*

Western Electric

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According to an old adage, genius is 1% inspiration and 99% perspiration.

We'd like to update that a little.

Because more than perspiration, a genius, like the rest of us, needs *information.*

All ideas come from information. All discoveries begin with it, and all decisions are based on it.

What really distinguishes geniuses is that they know how to *use* information—how to gather, edit, synthesize and otherwise manage it.

We raise the point because, by no small coincidence, managing information is what Xerox is concerned with, too.

We make copiers and duplicators to help you reproduce information.

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Or, to put it another way:

Genius is the inspired use of information.

You manage the inspiration.

And we'll help you manage the information.

XEROX

Edited at the Massachusetts Institute of Technology

Volume 81, Number 1
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# Technology Review

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## Articles



## Departments

## First Line

### To "Read" and To "Do"

It's fundamental that magazines give subscribers something to *read*. We like, too, to give you something to *do*.

So we continue to welcome Allan Gottlieb's "Puzzle Corner," the oldest "column" in *Technology Review*. For those readers who have special interest and aptitude in mathematics, we think Allan offers a unique opportunity for participation. Perhaps 100 readers write to him fairly regularly with solutions, and there is no way to know how many more solve some of his puzzles and wait quietly to compare their answers and methods with others'.

A decade ago Professor Philip Morrison of M.I.T. interested hundreds of students here by demonstrating in a seminar the powers of an utterly simple optical apparatus. Later we provided the same apparatus to every subscriber — a small white card with a cut-out window and a silvered mirror side by side.

In December, 1977, Owen Gingerich of the Center for Astrophysics showed his "Stonehenge decoder" — a pattern to be wrapped around a soft-drink can and a cut-out card to show how the ancients must have understood their great monument to the sun.

Now, on pages 28-49, David Marr and Keith Nishihara give us all a chance to explore stereo vision and three-dimensional perception. We hope you'll enjoy accepting their invitation, and that you'll tell us how well their dots come through to you. — *J.M.*

## Letters

### Reasons for Resistance

I was offended by Mark Rollinson's abysmal ignorance of the reasons why fallout shelters were rejected by the American public *(Popular Madness: Delusions of Disasters and Scarcity," March/April.)*

Sure, with enough shelters a lot of people would survive at least an initial nuclear attack. But what kind of a world would await them? The world would not be habitable after even a small-scale nuclear exchange. Not for human beings. A mere tenfold increase in the background radiation level of our atmosphere would eventually change the genetic inheritance of mankind so drastically that all generations after the second or third would be victims of multiple genetic defects.

So what possible value are air raid fallout shelters? Opposition to them is a healthy and realistic democratic reaction to the nuclear madness of our military leadership.

Roger Willcox
Stamford, Conn.

### Panic Over Pollution

Dr. Nisbet's article, "Flaws and Failures of the Clean Air Act," published in the March/April issue, is a rambling hodgepodge of unfounded charges, irrelevancies and exaggerated statements calculated to arouse emotional fears. For example, Dr. Nisbet irresponsibly paints the picture that "in the mid-1980's people will *still* be dying and gasping for breath" (emphasis added) as a result of poor air quality. He trots out the tired and disproven shibboleth "that many factories release pollutants at night and on weekends."

One irony is that after dismissing "the old-fashioned idea that there are threshold levels below which there will be no harmful effects" of air pollutants, he finally concludes that it is unrealistic to expect states to produce adequate air quality implementation plans by 1979, and to halt industrial development. Yet this foreclosure of industrial development is exactly what the present unrealistically stringent air quality standards and the Clean Air Act itself portend. Unfortunately, Dr. Nisbet's emotional fears overcome his scientific objectivity and his economic common sense.

E. D. Kane, Vice President
Standard Oil Company of California
San Francisco, Calif.

*Dr. Nisbet replies:*

If Mr. Kane thinks that present air quality standards are "unrealistically stringent," he should read the scientific literature (including the book cited in my article) linking air pollution to adverse health effects. If he thinks that they portend the "foreclosure of industrial development," his emotional fears are greater than mine. Indeed, I said specifically that the Clean Air Act would not be permitted to foreclose industrial development even in recalcitrant states. My point was that the Act, as implemented, has been economically inefficient, that it has not succeeded in protecting human health and is unlikely to do so. But this is not because present standards are unrealistically stringent. It is because they are unrealistically lax, and because Congress has granted exemptions to industries (including Mr. Kane's) which will prevent even these weak standards from being achieved.

### Electromagnetic Flight in Space

I have just seen Dr. Henry Kolm's interesting article, "An Electromagnetic 'Slingshot' for Space Propulsion" (June, 1977), in which he states that "Gerard O'Neill . . . first recognized the possibility of moving masses in space via electromagnetic propulsion."

This is quite incorrect, as Gerry himself has pointed out in *The High Frontier*. The technique was, I believe, first suggested in my paper "Electromagnetic Launching as a Major Contribution to Space Flight," published in 1950. The idea was later illustrated in my books *The Exploration of Space* and *The Exploration of the Moon*, and I used it fictionally in *Islands in the Sky* and the short story, "Maelstrom Two." (Perhaps the most extensive treatment in fiction of the Lunar Catapult and its possibilities is found in Robert Heinlein's *The Moon Is A Harsh Mistress*.)

A very detailed analysis of electromagnetic launching will be found in *Islands in Space* by D. M. Cole and D. W. Cox. Cole's *Beyond Tomorrow* contains a description, with illustrations, of a linear accelerator being used to move asteroids.

Also of great historical interest is the science fiction novel *Zero to Eighty* by Akkad Pseudoman (Edwin Fitch Northrup, the electrical engineer). Published in 1937, it contains a detailed mathematical appendix with photographs showing the model Electromagnetic launcher that Dr. Northrup constructed. He called it an "electric gun," which is certainly a snappy title.

Arthur C. Clarke
Colombo, Sri Lanka

### Inflammatory Uses of Magnesium

"The Coming of the Age of Magnesium" in your March/April issue (pp. 24-25) extols magnesium's virtues for transport equipment. Yet your discussion omitted a rather important drawback — the increased fire hazard.

On a New Year's Eve in Holland I once saw a car that was set on fire, and I noticed something uncanny, a white glare. This dazzling part of the fire gave me the impression that it would resist ordinary means of extinguishing it. Looking more closely I recognized the make of the wreck, D.A.F., and remembered reading an article about the lavish use of magnesium in Dutch D.A.F. cars. I was witnessing a magnesium fire. Having seen several kilograms of magnesium burning, I'd think twice about using this metal close to oil and gasoline in accident-prone vehicles.

Magnesium coins to lighten man's burden, yes; magnesium for bicycle parts, yes; magnesium frames for suitcases, yes: magnesium in motorcars, better not.

Herman D. Coster
Groningen, Holland

### More on the Neutron Bomb

Dr. George B. Kistiakowsky's article, "Enhanced Radiation Warheads, Alias the Neutron Bomb," (May, 1978) is colored by emotional, rather than scientific arguments. His thesis (that the ERW would be ineffective, excessively costly and militarily provocative, as well as inhumane) is not supported by the "facts" he relates to this issue. It is apparent that Dr. Kistiakowsky is using the ERW to make a much broader denunciation of all nuclear weapons, and this clearly biases his analysis and makes his case against the ERW less compelling.

The argument that Dr. Kistiakowsky advances to support his claim of ERW in-

effectiveness is distorted. It appears that the radiation output, in his mind, will be of little effect on troop units, while the civilian casualties, immediate and long-term, will be overwhelming. Indeed, if all troop units have a protected posture (unlikely in a battle situation) and if all civilians stand in the open on the battlefield (even more unlikely) then one can derive the "numerical" results of the battle to be whatever one desires.

Dr. Kistiakowsky attacks the "excessive cost" of the ERW but does not provide details to allow the reader to evaluate his claim — at least not in a budgetary sense.

The escalation potential of the ERW, the other major objection raised by Dr. Kistiakowsky, is less susceptible to direct support or refutation, in the absence of any real data. Virtually everyone touched by this issue has a strong opinion, and one can easily gain support from others of a like persuasion. But to argue that a weapon's utility makes it more militarily provocative is the first step toward unilateral disarmament.

On more specific technical grounds, I believe Dr. Kistiakowsky is incorrect in ascribing a 7:1 effectiveness ratio of high-energy neutrons to gamma rays in terms of biological damage produced. This "ratio" has been debated for many years and I believe that while it has yet to be conclusively determined, it is much less than 7:1. Also, Dr. Kistiakowsky uses the dose-time curve, (*p. 30*) to describe radiation effects, without recognition of the complex origin of this chart. The military targeting criteria (3,000-18,000 rads) is a conservative scale used by analysts to predict with some degree of confidence, what the *minimum* effect would be. This reduces the "calculated" military effectiveness. The civilian damage figures, on the other hand (200-450 rads), have been in use for many years and are probably "safe-sided" (i.e., 200 rads will cause *less* damage than predicted). This tends to inflate the civilian estimates. One must be aware of the philosophy behind this curve or risk misinterpreting the results of any analysis based on this data.

I wholeheartedly endorse Dr. Kistiakowsky's support of conventional precision-guided munitions, but he seems not to recognize the civilian casualty/collateral damage aspect of conventional weapons — despite the experiences of all previous wars. I detect here an attitude that war and death are to be expected, and accepted, but that it is only nuclear weapons that are inherently bad. I do not intend this letter to support enhanced radiation weapons; however, I do intend to support more rational and enlightened discussions on the issue than Dr. Kistiakowsky has provided in his article.

William D. Brown
West Point, N.Y.

CITIVIEWS

**CITIVIEWS is distributed quarterly to Citicorp investors. It contains viewpoints on timely public issues. We believe the following may be of interest to you...**

# Is Capitalism Kaput?

The word "capital" goes back to the Latin *caput,* meaning "head." Unfortunately, it is pronounced like a modern German word, *kaput,* which refers to something that is broken and doesn't work anymore. Many people, not all of whom speak German, seem to believe that this accurately describes the condition of modern capitalism, nor do all of them find this prospect displeasing.

Capitalism has never been good at winning popularity contests. It has always had more practitioners than friends. One reason for this is that it is the least theoretical of all modern economic systems. Or, to put it differently, it is a system where the practice comes first and the theory comes second. Theories of capitalism are mostly descriptive: Given the chance, people tend to behave in certain ways, and capitalist theories consist mainly of attempts to analyze the results. This is in sharp contrast to the various theories of socialism, all of which undertake in one degree or another to describe how people ought to behave—and then set out to create an economic system that will oblige them to do it.

When Marx and Engels published the *Communist Manifesto* in 1848, they used a considerable portion of their rather short document to warn the world against the blandishments of (1) reactionary socialism, (2) feudal socialism, (3) petty-bourgeois socialism, (4) German or "true" socialism, (5) conservative or bourgeois socialism, and (6) critical or Utopian socialism.

Socialism had not yet been established in any country; yet there were already at least six false forms of it for Marx and Engels to warn us against. Can anyone name six false forms of capitalism?

Capitalism began, not with a manifesto or flag, but as a series of economic and social pressures stretched over a long period. The interconnection of these events was perceived only long after the fact, and few if any of them were popular at the time. Their combined effect was revolutionary, and like all revolutions received a poor welcome from those securely situated in the old society.

Marx and Engels, writing at the inception of communism, gave capitalism great credit for its revolutionary role in history. One passage in their *Manifesto* is especially worth examining:

*The bourgeoisie, wherever it has got the upper hand, has put an end to all feudal, patriarchal, idyllic relations. It has pitilessly torn asunder the motley feudal ties that bound man to his "natural superiors" and has left remaining no other nexus between man and man than naked self-interest, than callous "cash payment." It has drowned the most heavenly ecstasies of religious fervor, of chivalrous enthusiasm, of philistine sentimentalism, in the icy water of egotistical calculation. It has resolved personal worth into exchange value, and in place of the numberless indefeasible chartered freedoms, has set up that single, unconscionable freedom—Free Trade.*

Since the authors of this statement clearly disapprove of the "motley feudal ties" that capitalism rent asunder, why does not capitalism emerge a hero? The clue is in that one word, *unconscionable,* which means "unrestrained by conscience." Why is Free Trade unconscionable? Because it is, by definition, free—and free means unrestrained. We are in the presence of a tautology, the absurdity of which can be shown by simply calling it Unrestrained Trade instead of Free Trade; thus capitalism is guilty of engaging in unrestrained Unrestrained Trade.

This confusion lies at the heart of the conflict between contemporary economic philosophies. If trade in the sense of commercial activity is never to be totally free, then under what restraints should it be compelled to operate, and who shall impose these restraints and by what authority? If conscience is to be one of the restraints, then the question becomes: whose conscience? The answers that society, knowingly or unknowingly, decides to accept today determine the economic system under which it lives tomorrow. This is a continuous struggle among human beings: All that varies from time to time is the intensity and form of the debate.

Two hundred years ago, Jeremy Bentham and his disciples were struggling to establish the principle of utilitarianism as the only proper guide for a statesman's conscience. For all practical purposes, the Benthamites have long since won their argument; all shades of political opinion now accept—at least publicly—the proposition that the only legitimate goal of public policy is the greatest good for the greatest number of people. What was once a controversial social and political movement has now become virtually axiomatic and is simply not discussed.

This very lack of discussion, however, tends to obscure some fundamental questions. Capital, after all, is nothing but the accumulated savings from labor performed in the past—a point on which Adam Smith and Karl Marx could easily agree. So what we are continually asking is: What is to be done with those accumulated savings, how—and whether—they will be replenished once consumed, and who shall designate the decision-makers?

One solution to that problem is an institution called the marketplace. It first appeared as the *agora* in Greek communities around 700 B.C. In contrast to the towns of ancient Mesopotamia, which had no formal marketplaces, the agora was the recognized center of the Greek cities, and it can be persuasively argued that the agora was the dynamic behind the seventh century upsurge of the Aegean peoples that led to classical civilization. As one historian puts it, "With a fistful of coins and an eye for the main chance, the individual had arrived in history."

It is doubtful that any marketplace has ever been completely free. The whole body of regulation by which modern societies set limits to the free play of economic self-interest implies the acceptance, either deliberate or unconscious, of moral standards by reference to which certain kinds of economic conduct are pronounced illegitimate. But even the most ardent believer in the proposition that free competition is "unconscionable" might still harbor doubt about whose conscience, exactly, is to supplant the unconscionable—unless, of course, he has become firmly convinced the conscience should be his own.

In the latter event he still has the problem of persuading the rest of us, which really amounts to moving the action from the marketplace to the political arena. The commonweal is sometimes enhanced by this maneuver, and sometimes diminished. History abundantly demonstrates, however, that people tend to pursue their own self-interest as determinedly in one arena as they do in the other, and that wherever they are free to make their opinions felt politically, some form of marketplace survives.

And where it does not, something has been lost far more precious than a theory or system of economics. It is not capitalism that is kaput, but freedom.

# The Sun's Elusive Effect on Weather

*Robert C. Cowen, Science Editor of the* Christian Science Monitor, *won the 1977 A.A.A.S.-Westinghouse Science Writing Award. He is former President of the National Association of Science Writers and is a regular contributor to the* Review.


Karen Watson

A perennial question on the fringes of meterology asks how "weather" on the sun may influence weather on Earth. Sunspots, flares, and magnetic force lines thread the interplanetary medium. Are correlations between solar activity and thunderstorms, air pressure patterns, wind circulations, and drought merely fortuitous? Or as veteran sun-weather correlator Walter Orr Roberts asks, do these "small and frustratingly fleeting clues" point to "mechanisms that may in five to ten years become a routine part of practical forecasting?"

Importantly, the reliability of computer-generated forecasts of upper air circulation patterns has recently been found to deteriorate directly after certain solar events. Dr. Roberts, former director of the National Center for Atmospheric Research and now with the Aspen Institute for Humanistic Studies, points out that these indications are based on only small preliminary studies. But should further research show the effect to be statistically significant, Dr. Roberts asks, might not this suggest that computer models of the atmosphere have left out an important mechanism which somehow transforms a signal from the sun into a modulating influence for weather?

"Heliogeophysics enthusiastics" (as Russian meteorologist Andrei S. Monin calls them) have speculated on this theme for over a century. Unfortunately, a dearth of satisfying answers has turned off most meterologists to a point where they no longer even hear the questions. They share Professor Monin's impression that most sun-weather correlations savor more of "successful experiments in autosuggestion" than of statistically valid inference. In these circles, mechanisms proposed to explain the solar influence "lack convincing substantiation." As for solar physicists, most of them give no thought to Earth's atmosphere at all — except as an inconvenience in their observations of the sun.

Nevertheless, a handful of scientists, working in the no-man's-land between the traditional disciplines, has brought the study of sun-weather relationships to a modest take-off, judging from an international conference on the subject held at Ohio State University this summer.

Dr. Roberts reflected this hopeful outlook in his keynote address to the conference: "We have, I believe, pretty solid evidence that there are *bona fide* influences of variable solar activity on the troposphere [lower atmosphere]. . . . The effects we observe are rather small and even esoteric. But they cause discernible responses where prevailing meterological theory suggests we should see none." He added, "If we can unravel what's happening physically, it may have profound significance for the forecast problem."

Sun-weather research may reveal the agents for large-scale weather and climate modification in addition to unfolding neglected factors in atmospheric processes,

believes Dr. Roberts. If solar activity is influential in minute doses of energies (which amount only to a fraction of a per cent of direct solar heating), he reasoned, the trigger mechanisms involved may be capable of release by man — deliberately or inadvertently.

**Scanning Solar Outbursts and Sunspots**

There are two correlations which even hardened skeptics cannot dismiss out of hand. Dr. Roberts has helped to supply one of them. Working with Aspen Institute colleague Roger Olsen, he has studied the relation between solar events and cyclonic (counter-clockwise) vorticity for the northern hemisphere. Roughly speaking, you can think of vorticity as the twist of the wind. It is a measure of the local angular momentum of the air flow. Thus, like changes of temperature or pressure, changes of vorticity are a basic factor in the weather machine.

To look for solar effects, Drs. Olsen and Roberts developed what they call a vorticity area index (V.A.I.) which represents this quantity as a large-scale average. They found that V.A.I. changes significantly followed large, abrupt geomagnetic storms, which reflect solar outbursts. Also, a major V.A.I. change occurred after the Earth passed through a solar magnetic sector boundary. In this narrow region of space the sun's magnetic field reverses direction; say, from pointing outward toward Earth, there the field will draw inward toward the sun.

Extensive and rigorous statistical tests now make these V.A.I.-solar correlations one of the best confirmed sun-weather clues. Another well-tested correspondence is the drought-sunspot correlation investigated by J. Murray Mitchell, Jr., senior climatologist at the National Oceanic and Atmospheric Administration. Working with C. W. Stockton of the University of Arizona, he has matched several hundred years of sunspot observations against a similarly long run of tree-ring data. His studies on tree-rings reflect moisture conditions over a large part of the western and midwestern United States. Dr. Mitchell finds a correspondence between the 22-year sunspot cycle and a roughly 22-year drought cycle which, incidentally, has led to the prediction that the U.S. is on the verge of a danger point in that cycle.

**Pitfalls of Prognosis**

Other correlations that intrigue the "enthusiastics" have less statistical verification. There are signs that thunderstorm frequency over large areas may be modified by action from the sun. Suspicious cycles that seem to echo the 27.5 day solar rotation period. J. W. King of Britain's Appleton Laboratory finds that same periodicity in global pressure pattern variations. Taken together, enough of these test out reasonably well to lead investigators such as Dr. King to insist that these clues command a full-scale investigation.

Though Dr. King's remark summed up the consensus of the conference, a number of speakers warned of the pitfalls of "autosuggestion." Correlations can mislead even when they are genuine. For example, Hans Volland of the University of Bonn, Germany, said that the 27.5-day cycles in weather elements such as those cited by Dr. King may only be coincident with the sun's rotation. He showed theoretical work that suggests the atmosphere has a natural tendency to approximate a 27-day cycle. So, he said, sun and weather may share a 27-day rhythm yet, on this time scale, be quite independent of each other.

A research report in the June *Bulletin of the American Meterological Society* emphasizes the whimsical nature of statistical correspondences. Thirty years ago, H. A. Panofsky of Pennsylvania State University working with S. L. Hess found that large-scale average winds on Jupiter were significantly correlated with winds on Earth. The implication was that some unknown solar influence affected them both. But an update on that study by Dr. Panofsky and Frank J. Lucadamo shows that original correlation to have disappeared. They warn that "apparently significant correlations may sometimes occur by chance and cannot be trusted until an independent test is performed." Although this particular report was not read at the meeting, similar warnings were made strongly by several scientists there.

Australian meterologist A. Barrie Pittock, now at the University of Arizona, made exceptionally pointed comments. He has gone over many of the correlations and finds virtually all of them statistically shaky. "Claims that solar cycle-weather relationships may form a useful basis of climatic prediction must be treated at present, both by researcher and consumer, with a high degree of skepticism," he concluded.

**Mechanisms for Weather Modulation**

This inclination to look at sun-weather correlations more critically is one sign of the field's growing maturity. A second indication is the willingness to face up to Professor Monin's other challenge, that of finding credible mechanisms by which solar events might trigger or modulate atmospheric processes. Here there still are no solid advances to report.

But there are hints. Reinhold Reiter of the Institute for Atmospheric Environmental Research in West Germany has discovered strong intrusions of stratospheric air masses into the lower atmosphere following solar flares. Other speakers suggested that changes in ozone high in the stratosphere may be part of the chain which effects weather on earth. Variations in solar ultraviolet output can alter ozone concentrations and distribution. Since this gas is important in heating the high atmosphere, such changes might point to a trigger that could affect weather lower down, especially if they are part of the process that brings stratospheric air to lower levels.

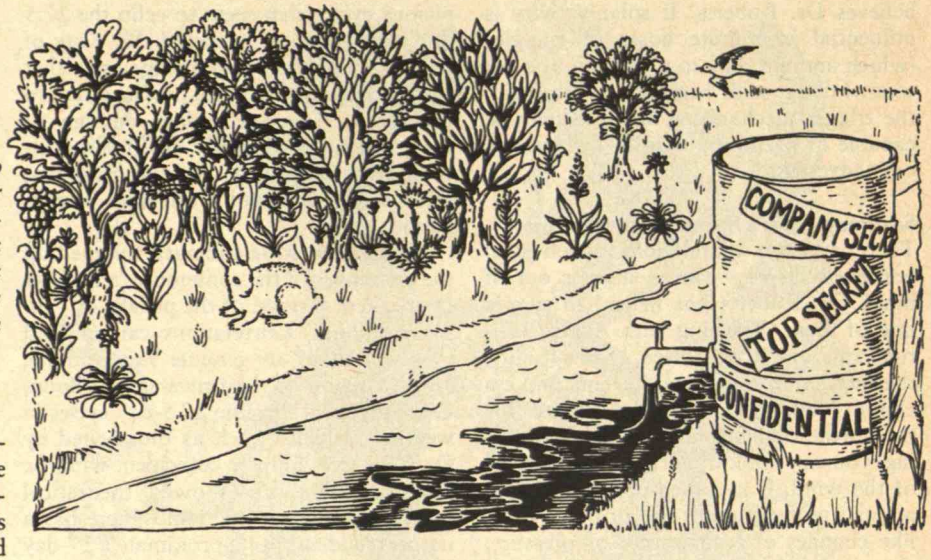
Another possible solar link may be through electrical effects. Charged particles from the sun can alter the ionization, and the conductivity, of the upper air. Solar magnetic fields can screen out cosmic rays which also affect conductivity. Through such effects, the sun might change electrical characteristics so as to modify thunderstorm activity, suggests Ralph Markson of the Massachusetts Institute of Technology.

All such mechanisms are speculative. They still can be dismissed as lacking "convincing substantiation." Solar physicist John Wilcox of Stanford University noted that the slow rate of progress is not surprising when you remember the decades of data gathering and synthesis by hundreds of people to elucidate the sun's influence on aurorae and geomagnetic storms. That was a simple problem compared to unraveling a solar influence in the complex, dynamic phenomenon we call weather. He feels no need to wait decades for meaningful progress. "We can build on the experience in understanding geomagnetism and we can be happy that many more scientists are coming into the field where there has been only a handful of workers up to now."

If and when scientists do solve the sun-weather problem to a point where solar activity can be taken into account in weather forecasting, they will face yet another Monin challenge. Such an achievement, he has said, ". . . would be almost a tragedy for meterology, since it would evidently mean that it would first be necessary to predict solar activity in order to predict weather. . ." This is something solar physicists are not up to yet. But that prospect doesn't dampen Dr. Robert's optimism. On this point, he says, "nature could just turn out to frustrate Monin." □

# Toxic Substances: Top Secret

*Ian C. T. Nisbet, who writes regularly for* Technology Review, *is Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. in Physics is from Cambridge University.*




Casserine Toussaint

All of the early signs of "Regulator's Disease" are already being displayed by the Environmental Protection Agency's implementation of the Toxic Substances Control Act (T.S.C.A.); inaction, missed deadlines, complex memoranda discussing and redefining basic regulatory strategies, and compromises on key points. Two years after its passage, T.S.C.A. has yet to achieve a single tangible result.

### Legislative Horse-Trading

A federal law to regulate toxic substances was first proposed in 1970. For six years, Congressional action was stalled by pressures from the chemical industry. Public concern during this period over repeated toxic chemical crises (PCBs, mercury, fluorocarbons, lead, PBBs, Kepone), served to strengthen the passage of T.S.C.A. Nevertheless, the process of legislative horse-trading had incorporated into the Act a number of important compromise provisions, which may eventually prove to be fatal flaws.

As it was eventually passed in 1976, T.S.C.A. had two principal features: to place upon the manufacturers of toxic substances the burden of testing for potential adverse effects; and to provide for restrictive regulation of substances which pose unreasonable risks of injury to health and the environment, taking into account the economic and social impacts of such regulation. In most cases these regulations require the generation of extensive data.

Additionally, the Act specified that substances should be regulated, where appropriate, under other Federal laws before invocation of the authority provided by T.S.C.A. For these reasons, it will probably be a number of years before any substantive regulation of toxic substances takes place under T.S.C.A.

The Act made a fundamental distinction between "new" and "old" chemicals. "New" chemicals are subjected to more stringent regulation, including a requirement for pre-market testing at the discretion of E.P.A. "Old" chemicals are those already manufactured or processed in the United States. The Act directed E.P.A. to compile and publish a list of "old" chemicals by November 15, 1977. Already this deadline has been bypassed by E.P.A.

This target was probably unrealistic: the final inventory may contain as many as 70,000 toxic substances and mixtures. Not all these chemicals may prove to be significant, but manufacturers reported to E.P.A. were inclined in cases of doubt to err on the side of inclusion, lest they be burdened by the more stringent regulation of those chemicals subsequently deemed to be "new." But other aspects of the Act hinge on the toxic substances inventory and its completion is unlikely before 1979.

### Industry's Fear of Exposure

The rock upon which the regulatory ship may ultimately founder is confidentiality. Assessment of the risks and benefits of toxic chemicals can be severely hampered by lack of data — not only data on toxicity, but also basic data on production, sales, uses, release rates, and human exposure. In my own experience, the lack of any systematic source of information on the uses of chemicals is the factor most obstructive to assessing both risks and benefits. However, much of this information is of commercial value to manufacturers, processors, and their competitors. In fact, fear of exposing trade secrets was the crux of the chemical industry's opposition to the Act.

Compromises written within the Act permitted manufacturers and processors to designate specific items as confidential, while granting E.P.A. rather extensive powers to collect data. In general, data on production and production processes would be treated as confidential, although most results of health and safety tests would not.

Already this issue of confidentiality has exploded in vigorous disputes between the Agency and manufacturers doing the first two years of data-gathering. Industry suspects (probably not without justification) that government agencies cannot be trusted to maintain the confidentiality of information supplied to them, however well-protected legally. The Agency feels crippled until they can obtain key information. Outside observers believe that the issue of confidentiality is being used in many cases to obstruct regulation, in the guise of protecting information which is of little or no value anyway.

Under pressure from industry and other branches of government, E.P.A. has relaxed their effort to collect comprehensive data. So that even when the toxic substances inventory is published, it will lack critical information on uses of these chemicals.

### Defensible Decisions

The development of testing rules for industry has anchored smooth regulatory sailing. With perhaps 70,000 chemicals to review (of varying doses and possible adverse effects) it is obviously impossible to assay every chemical for every effect. Priorities have to be set, in which the extent of tests for each chemical is tailored to the potential problems which it is judged likely to pose. The onus is especially great for "new" chemicals (or even

for new uses of "old" chemicals), for which the Agency has to specify appropriate testing within 90 days notice of intent to manufacture the chemical.

Accordingly the Agency has been sidetracked into seeking schemes for setting priorities and for making rapid, defensible decisions on testing requirements. Insufficient information makes such a process untenable, and the Agency seems unreasonably reluctant to recognize that good judgment must remain the decisive factor. A range of ideas on priority setting and on "hierarchical decision-making" have been buffeted around the Agency for several years. This cogitation has brought the Agency little nearer to decisive action than it was before the Act was passed.

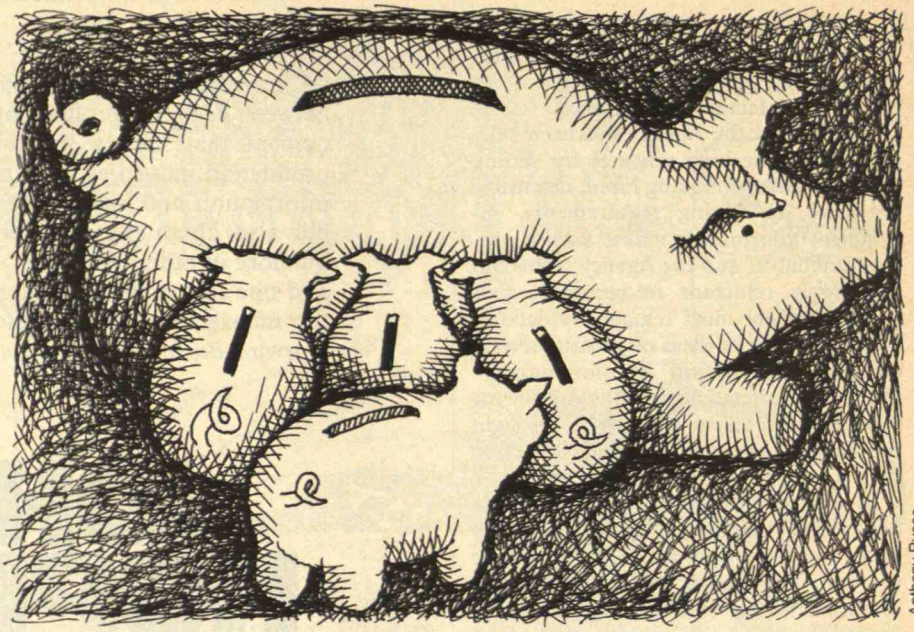
In view of this labyrinth, there is little hope for any significant regulatory activity under the Act within the next four or five years. Its only significant function will be to initiate testing of certain high-exposure chemicals which will assist regulation by other Agencies, such as the Occupational Safety and Health Administration or the Consumer Product Safety Commission.

But the Act, as it was written and as it is being implemented, will scarcely avert any of the chemical crises which led to its passage. Kepone, for example, should have been regulated under the pesticide, clean water, and occupational safety and health acts. Even PCBs, whose manufacture and use were banned under a specific provision of T.S.C.A., were phased out by their manufacturer before E.P.A. arrived at the scene. E.P.A.'s regulations for marking, retrieval and disposal of PCBs now in service are complex, tortuous and behind schedule.

The Agency has finally assembled a strong staff to implement the Act, and after a slow start it is beginning to put together a coherent program. But few people retain much confidence that T.S.C.A. will ever anticipate and prevent future problems posed by toxic chemicals — particularly those of the magnitude engendered by PCBs. □

# Making Capitalism Just

*Kenneth E. Boulding is President-elect of the American Association for the Advancement of Science, Distinguished Professor of Economics at the University of Colorado at Boulder, and a director of the Institute of Behavioral Science. He writes regularly for the* Review.



Anthony Russo

In the last twenty years proposals for making capitalism just by processes which will achieve a more equal distribution of capital ownership, and especially of equity capital ownership, have been rumbling around the intellectual underworld and show distinct signs of erupting in legislative activity. Some of these programs were anticipated back in the nineteenth century: certainly by von Thunen, a little more doubtfully by John Stuart Mill. In the twentieth century they are represented by at least one Nobel prize winner, James E. Meade. The present movement — and it well deserves that name — can be traced clearly to a book by Louis O. Kelso, with a laudatory introduction by Mortimer Adler, *The Capitalist Manifesto* (New York, 1958).

In the last few years Congress has passed a number of laws designed to encourage, mainly by tax incentives, the development of various employee stock ownership plans. A movement which has developed acronyms demands attention, and we now find in the great forest of society creatures called E.S.O.P. (Employee Stock Ownership Plans), C.S.O.P. (Consumer Stock Ownership Plans), I.S.O.P. (Individual Stock Ownership Plans), and a large spotted taxsucker called T.R.A.S.O.P. (Tax Reduction Act Stock Ownership Plan). All these birds have a niche in the social ecosystem and as it seems quite probable that these niches will grow, they have to be taken seriously.

These S.O.P.'s, if we can coin that name for this family of species, occupy rather different levels of the social forest and indeed may have niches in a number of different ecosystems, all of which makes for confused argument. At the high theoretical level in the tree tops there is wide agreement that the dynamics of capitalist societies produce too great disparities in the ownership of capital, especially equity capital, and in the net worths of the individuals or among families in the society. Unfortunately, the persistence of unacceptable equality seems inevitable in almost all societies. Even in socialist societies where the inequality of net worth may be less, the inequality of power and control is greater than in capitalist or social-democratic societies.

### Fortune From Fate

Under capitalism, there are two principal reasons for the persistence of inequality: the vagaries of luck make it almost impossible not to make life resemble a lottery; and a persistent, non-random element in the system, often called the "Matthew Principle," from that gospel's thrice-repeated phrase: "to him that hath shall be given."

A person, a family or a group gets richer by saving; that is, by not consuming as much as it produces. This comes easier to the rich than the poor. Indeed, the penniless have to consume more than they produce just to stay alive, so their net worth can only become increasingly negative. Whereas the affluent can profit solely by living within their income, which is quite easy to do. As the forces of the lottery therefore make some richer and some poorer, those fortune makes richer have a better chance to get richer, and those it makes poorer have a worse chance to get richer and a better chance to become still poorer.

This outcome is augmented by the fact that we get rich also by having a high rate of return — that is, net rate of growth on our capital — and these rates of return are distributed partly by luck, partly by skill. Though I suspect luck is the greater arbiter, the rich are more likely to skillfully employ their capital in forms which have a high rate of return, whereas the poor have a greater propensity to invest in those of low or even negative rates of return. This again accentuates the Matthew Principle. Add to this the fact that inheritance takes place almost wholly within the family, and that the rich often have small families, and the result is distressing dynamic pressure for generating inequality.

### Strategies for Equality

A question fluttering around the tree tops is whether policies, both public and private, can be incorporated within capitalism to offset the Matthew Principle and to push the ownership of capital towards a greater equality. Consideration of this question is of vital importance for the survival of capitalism. The failure to move towards equality is a serious criticism of all capitalist societies — though I would argue that despite this flaw, socialism fares worse in solving the real problem of inequality and creates a whole horde of other problems on the side. This simply means that we cannot rest content with any existing system and that the search for social invention must continue.

Most economists have dismissed the E.S.O.P. as a bit of a fable, radicals certainly regard the whole movement as a sop to capitalists, but I am not willing to dismiss it so lightly. For even if S.O.P.'s

are an inadequate answer to the problem of inequality, a partial answer may be a source for an overall strategy.

Other designs for expanding the basis of ownership may interact with these newly legislated programs. Various forms of employee ownership have been offered as solutions to other problems besides that of inequality. One aspires to increase worker control of, or at least input into, management decisions; and the second, to provide for old age in the form of pension plans.

Yet the ownership policies as a means to effect these is a little more doubtful. The feeling that the labor market divorces the worker from control of the enterprise in which he works is again a very old one and has been expressed, for instance, in the movement for producers' cooperatives. John Stuart Mill actually thought producers' cooperatives would take over the economy, just as Adam Smith erroneously thought that corporations did not have much future. These very distinguished clouded crystal balls at least induce in us a certain humility in prediction.

Even so, in Yugoslavia worker-controlled industry has been running into very serious problems. Though this may be a horse of a different color, it is a living species in the social forest and its relation to E.S.O.P.'s should be considered. The private pension movement is again something different. Yet, it raises a horrendous series of problems, because of the luck factor, and the enormous uncertainties involved in husbanding an increase in capital over a lifetime.

### Uncertain Notions of Exchange

Another part of the forest where S.O.P.'s have been on the prowl is in the discussion of the way in which production affects distribution, the exchange economy and the grants economy, where the excited cries of moral philosophers argue questions of justice somewhere above the tree tops.

Mr. Kelso believes that 90 per cent of all products is produced by capital and only 10 per cent by labor. I believe that the traditional three factors of production — land, labor and capital — are hopelessly heterogeneous aggregates and that production has to be interpreted in terms of know-how, energy, and materials, which adds confusion to his analysis.

Further, he says, labor receives approximately 75 per cent of this product in wages, which leads me to believe that there must be something wrong. Actually determining the proportion of national income channeled to labor income and to non-labor income is an almost impenetrable thicket. My own peculiar view about this — though not generally accepted — is that profits are indeed what Keynes called a "widow's curse" and that the more businesses distribute in interest and dividends, the more will return as profits. The only support for this theory lies in the great deal of evidence in its favor. If it is true, economic policy becomes almost unbearably complicated.

Where this leaves Mr. Kelso I am not sure, but he deserves at least one cheer for having brought out a question that most of us have been content to leave lying under the rug. If mine is an imperfect answer to a desperately important question, I hope others will pursue its challenge further, for the future of our society may well depend on finding better answers. □

# Trend of Affairs





## Afloat on a Sea of Methane?

Flames suspended in the heavens ignite the night sky in orange glow, while thunderous booms echo through the land. Lazy dogs growl unexplainably, and farm animals are restless. The sea froths and boils; fish die; and bottom-dwellers roam the surface. Then the ground trembles and disaster strikes — an earthquake cripples the region, taking many lives and destroying homes, villages, sometimes whole cities.

Mysterious phenomena associated with earthquakes have been faithfully chronicled since ancient times, when eyewitness accounts were set down on papyrus and stone. The records often explained the phenomenon as omens sent by the gods to warn of impending doom.

Until recently modern scientists were apt to ignore ancient observations as laced with such superstition, but no longer. M. Nafi Toksoz, Professor of Geophysics at M.I.T., reports that villagers in eastern Turkey observed strange occurrences such as booming sounds and unusual behavior of dogs up to two weeks before earthquakes struck in September, 1975, and November, 1976. Geologists noted a brightening of the sky the night before the first earthquake there. In Japan, sightings and photographs have documented bright night skies before an earthquake. At the April meeting of the American Geophysical Union three University of California investigators described cases of peculiar animal behavior — a restless Arabian horse, a cat that refused to sleep, and a nervous Doberman pinscher — that preceded an earthquake in Willets, Calif., in November, 1977.

Their new theory explaining the occurrence of such pre-earthquake phenomena centers on methane. The explanation, developed by Thomas Gold, Professor of Physics and Director of the Center for Radiophysics and Space Research at Cornell University, begins, as you might expect, in outer space.

Many astrophysicists and planetary scientists, Professor Gold among them, have pondered the uneven distribution of elements among and within the planets. If the solar system coalesced from a cloud of gases and minerals, how is it that these materials are now so unevenly distributed among the planets? Why should carbon, the central component of all organic molecules, be concentrated only in the upper fraction of the earth while so little is found in the deeper rocks formed at greater depths?

Professor Gold told an M.I.T. seminar this spring that he supports the hypothesis that assumes carbon was once distributed throughout the volume of the earth. According to the hypothesis, first formulated by geochemist Harold Urey, the founder of modern planetary chemistry, carbon from deep within the earth has been carried to the earth's crust in the form of hydrocarbons, molecules composed of carbon and hydrogen. Deep below the surface, the hydrocarbons convert to the gas methane ($CH_4$), which has a simple and stable molecule which can survive high pressures and temperatures up to 2,000 °C. Gradually the great pressure deep within the earth could have forced the methane through porous strata and microcracks toward the earth's crust, says Professor Gold. Eventually the methane reached the atmosphere where several cycles of organic and inorganic reactions dissociated it into its components carbon and hydrogen.

Professor Gold proposes that there should be places where the leakage of gases from deep within the earth can be detected. This leakage, called outgassing, is a feature of most theories of planetary development, and Professor Gold assumes that the process continues on earth today. Volcanoes are one obvious outlet, and there are also known points of leakage around the earth's large petroleum deposits and major fault lines — the sites of earthquakes.

Professor Gold speculates that methane escaping through faults in the land surface catches up small grains of dust or dirt that collide, creating sparks that could ignite the methane and cause the flames and explosions so often reported prior to and during earthquakes.

Other gases escape with the methane — notably small traces of poisonous hydrogen sulfide, and Professor Gold believes the boiling ocean is a direct result of this outgassing underwater. The methane and hydrogen sulfide may also be responsible for the observed uneasiness of animals, the sulfurous odor associated with earthquakes, and fish kills and the unsettling of the bottom-dwellers.

Crews aboard ships at sea, upon seeing the brightly flickering skies and hearing distant booms, have rushed to what they thought was a burning ship. They found

nothing, except in some cases, a frothing, bubbling sea. Methane flames? Perhaps, but Prof. Gold is still unsure how the gas ignites over water.

He explained how methane release could also account for occurrences of ocean-like waves in alluvial soil during earthquakes. The earthquake-induced upsurge of methane becomes trapped under the pliable, blanket-like layer of alluvial soil. The soil floats on the methane and exhibits wave-like motions until the gas breaks through into the air.

Professor Gold suggested that the upwelling of inorganic terrestrial carbon — not the chemical conversion of waste organic matter from the surface — is the source of petroleum. His idea is based on the common association of methane leaks and petroleum deposits — deposits he states are simply too numerous and too large to have resulted from fortuitous biological decay. Pennsylvania's most productive gas well is from a methane source that is not petroleum-related, he said. Methane may be an abundant fuel occurring deep throughout the earth's crust, he says. Such a supply of methane would be a potential energy resource that could last for millions of years. — *Roland B. Thompson* □

## Earthquake Research and Political Tremors in China

Politics have all too often hindered science, and no example is more dramatic than the way Chinese political philosophy has affected earthquake research in China.

University of Colorado geologist Carl Kisslinger explains that China's politics will have serious effect on the usefulness of its earthquake research.

"Progress in science is important to the Chinese, but less important than progress in socialist reconstruction," said Dr. Kisslinger. "The evidence we have shows that if the two are in conflict, science must wait." He participated in the Academy-supported Committee on Scholarly Communication with the People's Republic of China.

According to Dr. Kisslinger, China possesses both the motivation and the opportunity for achieving great advances in earthquake prediction. Since an average of five or six earthquakes with magnitude greater than six have occurred in China each year since 1900, "the Chinese have a good chance to collect data concerning earthquake precursors," said Dr. Kisslinger. The geology and plate tectonics of China also offer unique chances for new data. The large population at risk provides the research with a political impetus, for population concentrations coincide with areas of high earthquake danger in

Electronics

## Detecting Smoke With a Single Chip

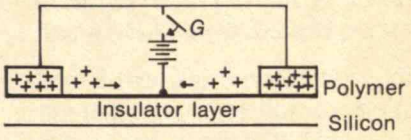
Given a series of polymers (plastics to most of us) whose electrical resistance varies with the amount of humidity, smoke, or ammonia in the air, any engineer worth his salt would think of using them as detectors of these environmental components. Such polymers exist, but their changes in resistance are infinitesimal; reliable devices based on the amplification of such tiny differentials have long seemed impossible.

Now its inventor says the "charge-flow transistor" is changing all that. The new device may open an entirely new technology for detecting gases and air-borne pollutants.

Consider how a water-vapor detector could be fashioned. A sheet of water-vapor-sensitive polymer is sandwiched between two sources of positive electrical charge. When a pulse of voltage is applied, charges begin to penetrate the polymer much as heat penetrates a roast of beef — slowly, from the edges toward the middle. If the atmosphere is heavy with water vapor the penetration will be faster than if it isn't but the actual flow of charges is very small, water vapor or not. But now add a thin layer of insulator under the polymer and under that a layer of silicon. The silicon acts as an insulator until charges are present in the polymer above it. When enough charges accumulate in the polymer, the silicon suddenly becomes a conductor. The time required for this transformation to take place turns out to be a sensitive measure of the accumulation of charges in the polymer — and hence of the humidity in the polymer's environment.

Stephen D. Senturia, Associate Professor of Electrical Engineering at M.I.T., says this "charge-flow transistor" is perhaps 10 million times more sensitive than conventional ways of measuring resistance in a polymer layer. And the whole device — polymer, insulator, and silicon layers — can be fabricated as an integrated circuit which performs both sensing and amplification in a single semiconductor chip 1/20th inch square.

One of the first applications of the concept is likely to be in an inexpensive, sensitive smoke detector, using a polymer whose resistance is changed by the presence of the ionized particles

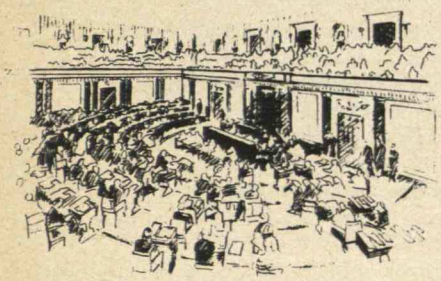



in smoke. A polymer sensitive to water vapor — our example above — is presently being used in a humidity-measuring circuit, and one sensitive to ammonia will soon be tested as an ammonia detector. Indeed, applications of the principle seem to be limited only by the availability of polymers whose resistance is changed by the presence of whatever one wants to detect. Some of these have been explored for detecting spacecraft pollutants by Norman Bird of McDonnell-Douglas. Professor Senturia mentions especially the search for a polymer which could be incorporated in a "charge-flow transistor" to detect levels of carbon monoxide pollution.

The National Aeronautics and Space Administration supported development of the polymers Dr. Bird and Professor Senturia and his students have used thus far as well as of the "charge-flow transistor" concept itself. — *J.M.* □

# IMAGINATIONAL PUBLIC RADIO

Imagine...you're on the floor of the U.S. Senate. Around you the Senators are moving to their seats.



The scene is overlaid with a muted wave of chatter from the visitors' gallery. The Vice President raises his gavel, and with the first resounding rap, the room is silenced...The Panama Canal Treaties debate begins.

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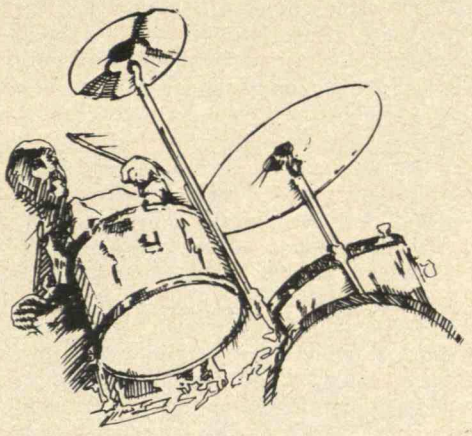

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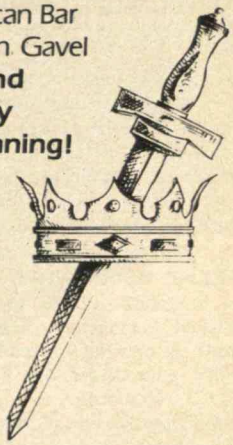

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China, and the predominantly rural Chinese housing is not amenable to earthquake resistance engineering. "The total Chinese deaths from earthquakes during the past six centuries, of the order of 2 million, including the estimated losses in the disastrous T'angshan event of July, 1976, far exceed those in all other countries combined," he said.

The big question, said Dr. Kisslinger, is whether the politically governed organization and technical preparation of Chinese scientific workers will allow the Chinese to make significant contributions to earthquake prediction. Despite the considerable money and manpower devoted to the area, "both the educational system and the fundamental research philosophy will tend to diminish the quality of the work that might otherwise be accomplished," he said.

Chinese education places very high priority on practical problem-solving, and theory has been greatly de-emphasized. All post-graduate education has been eliminated and all advanced training is carried out on-the-job. The de-emphasis of theory will "serve to reduce the importance of the results to be produced below the potential," said Dr. Kisslinger, and he charged that the Chinese educational philosophy "seems to have resulted in the almost total absence of an effort in original theoretical studies."

The widespread use of amateur observers to take earthquake data does increase the likelihood of bad data being taken, said Dr. Kisslinger. "The effective use of this large manpower base is, nevertheless, one of the great strengths of the program," he pointed out.

Finally, according to Dr. Kisslinger, the Chinese remain somewhat aloof from their international colleagues and "do not seem interested at this point in putting their work into a global context." So the world's geophysicists can only eye the tempting possibilities for earthquake research in China, and hope that some political upheaval doesn't spoil a chance to study geological ones. — *Dennis Meredith* □

Macroengineering

## Squads Against Disaster

An explosion rips through the dark night of a small midwestern town. From windows heads poke out, expecting armageddon. The grain elevator that sits smack in the center of town is a fiery inferno. After years of winking at safety standards, the elevator's owners, Arkville's largest employers — and now the town, too — are paying the piper.

Horror mounts as rescue operations begin. Over 250 people are dead; many more are injured. The mayor, doctors, lawyers, and teachers, some of the most successful farmers in the county, and the elevator's owner are carried from the remains of a small building near the elevator where the town leadership had met in a last futile attempt to protest the elevator's lax operation. By morning outside assistance has been mobilized and has arrived in full force to help clean up the damage and guide the town through the first desperate month after the disaster.

Yet for Arkville, clean-up efforts are only a band-aid treatment. Recovery is slow. Without its leaders and its main employer, Arkville is left without head and heart.

Five years later, Arkville's citizens are still shell-shocked. The worst has happened to this town: with the assistance of government grants and insurance, the town rebuilt the elevator in the same location. Not unexpectedly, a second explosion destroyed the new elevator. The disheartened townsfolk, still in mourning over the first disaster, have lost all hope. Arkville is fast becoming a ghost town.

Arkville is mythical: its problems are not. The helplessness of a town plagued by disaster that forethought and some creative thinking could have avoided is a familiar tale. Arkville's demise was, in fact, the creation of William Wilcox, Director of the Federal Disaster Assistance Administration (F.D.A.A.), a scenario for a three-day think-tank on "Learning from Small-Town Disaster" at the Institute on Man and Science in mid-summer.

Mr. Wilcox is frustrated by the lack of long-range planning for disaster recovery. Too often in cases of community trauma due to fire, flood, earthquake, or explosion, relief efforts are curtailed before the town's long-term economic and psychic recovery has begun. In effect, short-term relief is the doctor that cures the disease but loses the patient.

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Large-scale engineering projects, such as the Pyramids of Egypt and the Great Wall of China, have captured the imagination throughout human history. The Jubail Industrial Complex (rendered below) is one such vision for modern times, presently under construction in Saudi Arabia. In 20 years, a 10-mile stretch of desert will be transformed into a thriving city of 300,000 residents, complete with airport, harbor, petrochemical and other industrial facilities. (Drawing: Bechtel Corp.)

The purpose of the Institute forum was to invent new, less conventional approaches for institutional response to small-town disaster. Its strategy was to summarily sentence Arkville and three other imaginary towns to disaster, and then direct the participants to play the part of these towns' citizens, who must pick up the pieces.

The actors the Institute called in were not unfamiliar with disasters. Planners and relief agents from Nebraska, West Virginia, and Kentucky, like Mr. Wilcox, shared tales of long-term plans that had failed. Roy Newsome, who works with Mr. Wilcox at the F.D.A.A., kept a keen eye on cash flows. Ann Martindell, who heads the U.S.A.I.D. Foreign Assistance Office, met with her counterparts on the federal team for the first time and gave no sign if she had heard it all before. Most of the other 40-odd participants were veterans of small towns that have so far successfully avoided disaster, but no one was sure how. And every so often the famous elaborator of science fact and fiction, Isaac Asimov, would comment on the groups' progress.

The real obstacle to long-range planning, said Dr. Asimov, is the pre-disaster apathy that has bequeathed responsibility in the assumption that somebody else is in charge. "Not taking precautions is common," he said. "People think that taking precautions eats into their spare time, and that looks like a sacrifice." He cited the principle of least action, saying, "It's always easier to go downhill than up."

Perhaps planning for disaster is as fruitless as whistling in the dark. Disaster, Frank Davidson of M.I.T. pointed out, comes from the Latin for ill-starred. Astrologers' claims aside, the word still connotes workings of fate that elude mortal control. Dr. Davidson, who headed the meeting with Dr. Asimov and Mr. Wilcox, taught a popular M.I.T. course on the uses of failure — thus his interest in planning for disaster, the ultimate failure.

Disaster, he says, can be opportunity in disguise: at the very least, an opportunity to learn; at best, an opportunity to change for the better.

The people at the seminar agreed. From their imaginary scenarios of the worst possible fates for their catastrophe-prone towns came a common thread — a Humpty Dumpty theory of disaster relief. The disaster victims' first response is often to try to put the pieces back together the way they've always been. In most cases, this is the worst that can happen.

To respond to this natural tendency, designs for long-term relief should incorporate ideas offered by outside interveners. Alone, traumatized towns can't be expected to pull together in innovative, bootstrap operations of revitalization. Such an approach is wishful thinking, and should be shelved under the rest of the technological fixes, the group agreed.

One solution, offered by Dr. Davidson, is to found an Institute for Learning from Disaster that harbors a squad of consultants who act as ambassadors of practical encouragement for towns recovering from disaster. Another strategy is to base intervention on the capabilities, rather than the needs, of the people who are aspiring for self-help. A national disaster community response could locate business opportunities, people to run them, oversee the financing (and negotiate with local funds), and advise on new investment decisions. The philanthropic nature of this institution would preserve it from "carpetbagger syndrome." "Disaster is a growth industry," said Dr. Davidson. "Why not take advantage of that?"

Small-town America still cozies up in its easy chairs to watch the evening news of strikes in Cleveland and earthquakes in Guatemala with smugness from confidence that "it can't happen here." But what when that confidence proves false? Said Dr. Asimov, "Optimism can lead to carelessness and apathy. Pessimism can lead to gloom and despair. There has to be a balance." — *S.J.N.* □

## The Care and Feeding of Macroengineering Projects

If the Pyramid of Cheops or the Great Wall of China were rebuilt today using the original techniques, they'd each take about 20 years to build and cost around $20 billion. Of the same order of magnitude is the Jubail Industrial Complex, a pre-planned metropolis now being grafted to the sands of Saudi Arabia. This modern macroengineering project (M.E.P.) was one of many explored at the annual meeting of the Association for the Advancement of Science last winter in Washington, D.C.

Over the next 15 years Jubail will rise from a 20-mile stretch of desert along the Persian Gulf preparing to welcome 300,000 residents. The city will include an industrial complex accomodating 16 major industries, as well as a harbor and airport. A peak of 42,000 workers and thousands of engineers from a total of some 30 countries will have contributed their resources and expertise by the time the project is completed.

The grandiose construction of Jubail is a paradigm of the complexity of modern M.E.P.s. Invention is not the major problem, but organizing, scheduling, and planning, stated Richard Godwin of Bechtel, Inc., the engineering and construction firm managing the first five-year

phase of the project. Delays can cost one million dollars per day on a project of this size, he pointed out, emphasizing that $15 million was allotted for planning alone. People with the required management skills are rare, he said.

M.E.P.s have always attracted the unique individual. They are visionaries, like Leonardo da Vinci, possessing insight into the special requirements of their times, explained Dr. Eugene Ferguson, Professor of the History of Technology at the University of Delaware. But the demands of modern M.E.P.s are far more numerous than the kingly prerogatives of the past.

If a director for an M.E.P. is hard to find, the person with the pursestrings has become extinct. Few of these M.E.P.s can promise profits, said Wallace O. Sellers of Merrill Lynch, Pierce, Fenner and Smith, Inc. Mr. Sellers was involved in the Chesapeake Bay Tunnel financing, which he characterized as an "absolute disaster" because of an overblown traffic estimate. But prudent use of debt financing will be the future of M.E.P.s, backed up with a guarantee from the participating government. We are no longer intimidated by large numbers, said Mr. Sellers of his firm, which has invested in over 200 projects each of which cost more than a quarter of a billion dollars.

Aesthetic and psychological motives have played the muse for large scale undertakings of the past. For example, the impetus for the Panama Canal was nationalistic and not economic, claimed Professor Ferguson. But the search for financiers gives a powerful argument to translate the exotic into a promise of social good. A sample of the M.E.P.s reviewed at this session all claimed to answer — at least partially — some of the most challenging problems facing our society:

☐ An orbiting solar collector system that would beam energy back to earth using microwaves, which are then converted into electrical energy. The first solar power generator could be put in orbit by 1995, and would cost $10 billion, according to Peter Glaser, Vice President of Arthur D. Little, Inc. The generator could provide five million kilowatts of power — about as much as from five current nuclear powerplants.

☐ A mass-driver that "bags" earth-approaching asteroids and brings them to space manufacturing stations near earth. The raw materials from these asteroids could be used to build satellite power stations or space colonies and could relieve our limits to growth on earth, said Brian

T. O'Leary, Research Physicist at Princeton University.

☐ The use of thermal energy contained in the oceans. The U.S. Department of Energy has scheduled the construction of a prototype floating power plant for 1979 that would use the temperature differential between deep and surface waters to drive turbine generators *(see pp. 58-63)*.

☐ A transcontinental subway that could reach speeds greater than aircraft and using substantially less energy *(see June/July, p. 21)*.

We have the technological capabilities to complete most of these projects. But this expertise should not seduce us to the appeal of the fabulous. Often the works of "these visionaries may have great technical defects," warned Professor Ferguson. Builders of the *Great Eastern*, an iron ship constructed in 1858, tackled incredible problems of scale. But its success as the largest ship for the next 100 years was marred by the fact that it required an exorbitant amount of fuel and proved useful only when used to lay the Atlantic cable in the 1860s. Engineers rarely consider the social costs of their systems, said Professor Ferguson, who insists on the involvement of non-technical critics to assess these costs.

One such critic is Howard Margolis, Fellow at the Center for International Studies at M.I.T. The monumental, today, is more than an edifice; it is a transformation of our environment. We need to be wary of the environmental and political implications of M.E.P.s, said Dr. Margolis. Programs which seem beneficial to one nation later mark them as villains in the eyes of others, he remarked, alluding to the outcome of the S.S.T., and to a Soviet plan to reverse the flow of Siberian rivers. While intended to improve irrigation and raise the level of the Caspian Sea, such a large-scale reversal might also cause the Arctic ice cap to melt. This side-effect would clearly be beneficial to the Soviets, stated Dr. Margolis, as it would create a warmer climate for Siberia, but the effects of such continental restructuring is uncertain, at best. He predicts that these kinds of issues will arise more frequently toward the end of this century.

Another hazard is the tendency to propose M.E.P.s as "technological fixes." One is apt to find these macroengineering "fix" suggestions in situations in which people are being asked to give something up, observed Dr. Margolis. Some of the proposals to reverse the effects of $CO_2$ buildup in the atmosphere are just not realistic, he commented, citing a scheme to freeze emissions from fossil fuel plants and sink them under the oceans. "It's an upside-down look at existing environmental issues." — *S.F.* ☐



Energy

## Storing Electric Power

Like a perishable fruit, electrical energy is hard to store; it has to be consumed as it is generated or it is lost. If the consumer is to have power upon demand, the public utilities' production must be fine-tuned to increase in the evenings, decrease at night, and go way up on hot afternoons or on that November morning when millions of turkeys go in the oven.

But electric generators are not flexible. Almost without exception, whether coal-, oil-, or nuclear-powered, electrical plants operate most efficiently at an even and continuous level of output. Hence the utilities' unrelenting curiosity about devices that store electricity, so that power generated at times of low demand can be kept in reserve for times of peak need.

Batteries store electricity. They work well enough to hold energy made by an alternator on a commuter's home-bound trip until it's time to start the automobile again the next morning; a battery can operate a radio when the wind fails to drive a wind charger; one can run a small automobile as far as 100 miles. In comparison, utilities' storage problems are of a gargantuan scale. An example of the gold at the end of the rainbow: if half of the peak power (power in excess of their average demand) that U.S. utilities will have to supply in 1986 could be met by energy made — and stored — at times of minimal demand, the utilities would save the equivalent of 3.6 million barrels of oil each day, the equivalent of nearly 300,000 megawatts of power.

For utilities, mechanical systems promise far more than do chemical ones. Several variations on two promising systems

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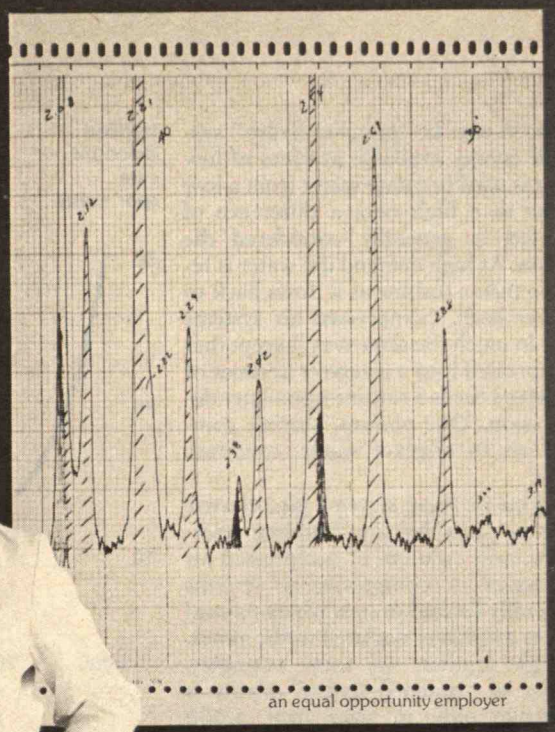

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are now in use. In "pumped hydro" systems the energy available at times of low demand is used to pump water from a low reservoir to a high one; a difference of 2,000 feet is generally considered the minimum. At high demand the water is released to turn a turbine as it flows back to the lower level. Compressed air systems operate in much the same way, except that air compressed into a reservoir at times of low demand turns a turbine upon later decompression. One variant, storing compressed air to displace water, combines the two.

But none of these systems give electric companies cause for joy. Building reservoirs for large volumes of compressed air is impractical, so compressed air systems are generally limited to sites where natural storage is available: depleted wells, mines, or airtight aquifers are some examples. The cost of "pumped hydro" plants is competitive only in sizes near 2,000 megawatts. Surface reservoirs (filled half the time, empty the rest) are unpopular among environmentalists, and underground reservoirs are expensive. Compressed-air storage plants are likely to be noisy, and the heat produced by the compression itself may also be an environmental issue.

Constraints on further exploitation of these storage devices are not related to uncertainties in the systems technology. Utilities responding to a questionnaire from six engineers at Argonne National Laboratory and at the University of Illinois at Chicago Circle listed three areas in which research is needed:

☐ in prediction of underground geology, to eliminate a major source of uncertainty in building reservoirs;

☐ in allocation of risks and management of jurisdictional labor issues;

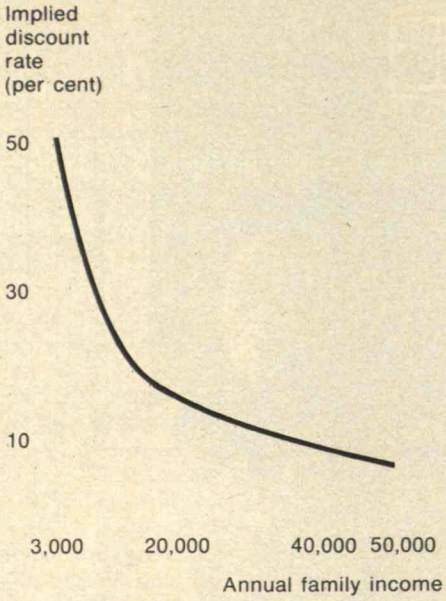
☐ in the effects of cycling on reservoir stability.

The engineers estimated the installed cost of "pumped hydro" systems at $200 per kilowatt hour (1975 dollars), and that of compressed air systems at $115 to $300 per kilowatt-hour. — *J.M.* ☐

## When We Spend, When We Don't, to Conserve

If you spend an extra $50, you can buy an energy-efficient appliance which will save you, in the first five years, a total of $45 on your electric bills. If you put the $50 in your savings account, it will earn just over $20 in interest in the same time.

The average American would put his $50 in his savings bank.




Economists call it consumers' "defective telescopic faculty" — the fact that the average buyer will leave his money in the bank at 5 or 6 per cent instead of investing in an energy-efficient appliance which promises to return 15 per cent interest on the incremental investment. Analyzing data from Midwest Research Institute, Professor Jerry A. Hausman of M.I.T. finds that this individual discount rate differs according to the purchaser's total income; it suggests that an energy policy designed to stimulate conservation should be based on tax credits having the form of subsidies, he says.

Nothing really surprising about that to Professor Jerry A. Hausman of the M.I.T. Economics department. It's a recognized phenomenon economists call a "defective telescopic faculty" — the observed fact "that, in making decisions which involve discounting over time, individuals behave in a manner which implies a much higher discount rate than can be explained in terms of the opportunity costs of funds in credit markets."

Nor is it really surprising to Dr. Hausman to learn, from the same data — a survey by Midwest Research Institute of home air conditioner purchases in 1976 — that an individual's discount rate is likely to vary inversely with his income. The high discount rate of the poor is obvious enough: they lack funds to invest, and their income streams are uncertain at best. The same rationales in reverse explain the relatively lower individual discount rates of wealthy people (see chart).

Given these high individual discount rates, what energy policy will give the government maximum energy conservation for its investment? Dr. Hausman's choice is tax credits, to lower the price of energy efficiency in the marketplace; this will have the effect of increasing the rate of savings implied by the purchase of energy-efficient devices. Tax penalties, such as "gas guzzler" automobile surcharges, far less leverage on consumers' pocketbooks. — *J.M.*

## Agriculture and Energy: Let Them Burn Cobs

Frank G. Zarb, who has given up trying to manage federal energy policy in favor of trying to manage a major academic enterprise (he is now President of New York University), has some advice for his successors in Washington.

"It remains to be seen . . . when the U.S. government will realize that its most significant contribution to the American people is to know when to get out of the way and let the system . . . do its job," he told the American Association for the Advancement of Science last winter. Factories are saving energy because managers can see the results on the profit and loss statement; utilities are converting to coal because they can save money and reduce supply problems; and Americans are buying more economical cars and turning their thermostats down because of what they read on their fuel bills.

The lesson is obvious: when you talk to an entrepreneur about energy conservation, talk not to his conscience or his Congressperson; talk to his wallet.

It's the same when you talk to a farmer about energy conservation, says Bruce A. McKenzie, who has spent his life in American agriculture, first as a farmer and now as a teacher at Purdue University. The farmer's priorities are just like everyone else's; the only difference is that he may have more at stake.

Consider, for example, the corn-belt farmer in Professor McKenzie's state. For best yield, corn must flower when the sun shines hottest. In Indiana this means a 15-day planting peroid in late April. Given the eccentricities of spring weather, this translates into no more than seven to nine days — sometimes less — in which to plant several hundred acres. No wonder the farmer wants a fast, powerful, dependable tractor. To prepare the soil and cultivate the crop may take 2.5 gallons of diesel fuel per acre, $1.50 worth. A smaller tractor could do it in two extra days on

only 2 gals./acre, but the saving in money in no way offsets the extra risk.

At harvest time, this farmer will use a gas heater to remove much of the moisture from his shelled corn — from 25 to 15 per cent by weight. In a good season that means 6-cents'-worth of gas per bushel, says Professor McKenzie — an investment that clearly pays off in reduced spoilage with corn priced at about $2.60 per bushel.

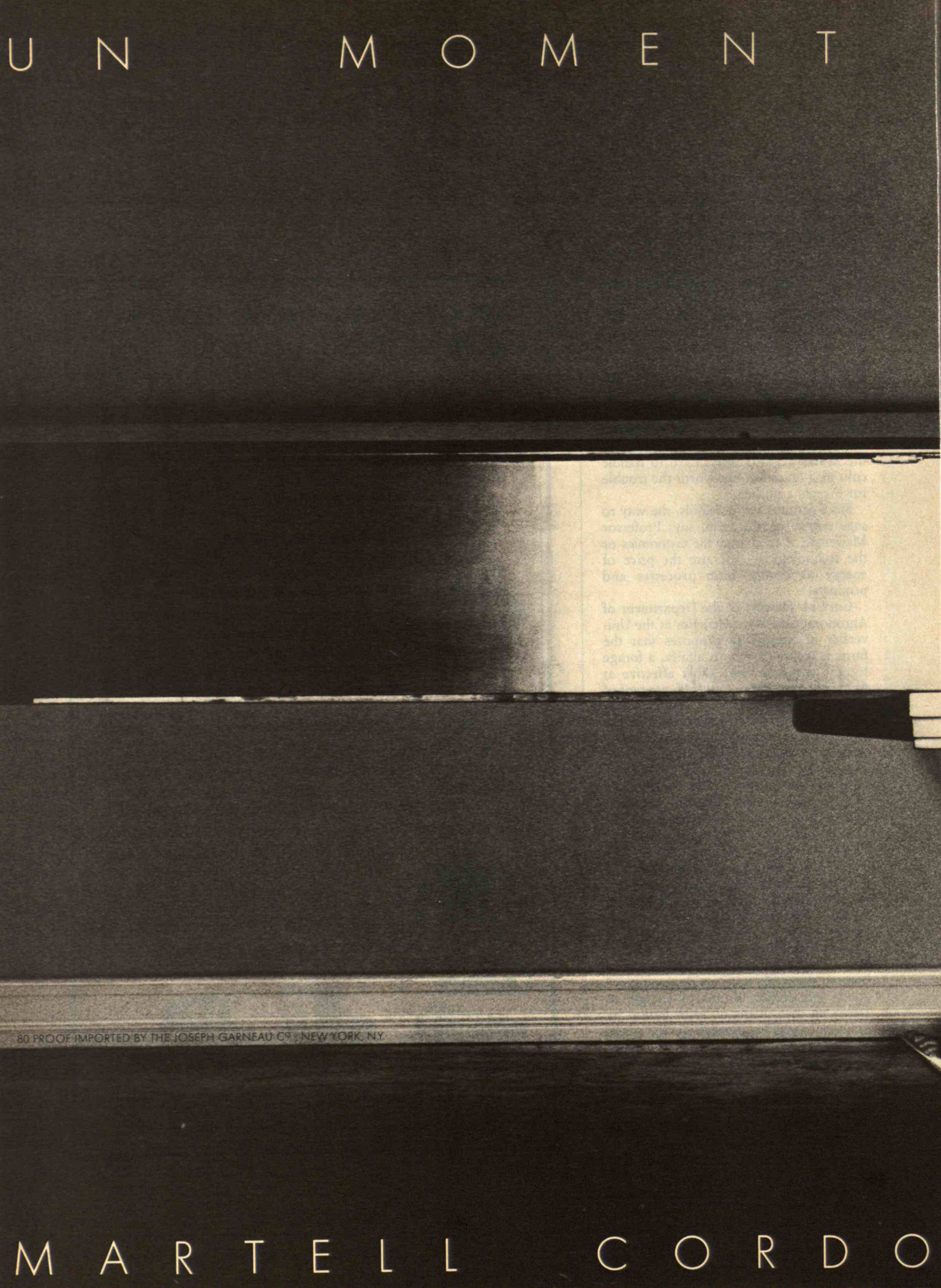
Farmers could conceivably burn corn cobs instead of gas to dry the shelled corn. There are plenty of cobs — 1,000 pounds per acre, if the corn yield is good. But the harvest season is a critically busy one, and the farmer regards dirty, hard to handle cobs as a nuisance, not worth the trouble for 6 cents a bushel.

Since farmers are not fools, the way to save energy on the farm, says Professor McKenzie, is to change the economics or the technology — to raise the price of energy or change farm processes and products.

Gary H. Heichel of the Department of Agronomy and Plant Genetics at the University of Minnesota proposes that the farmers rotate corn with alfalfa, a forage legume which is remarkably effective at fixing nitrogen in the soil. If 10 per cent of U.S. corn were grown in rotation with alfalfa, the demand for fertilizer in the corn belt each season would be reduced by enough to save 28 billion cubic feet of natural gas, the energy source for most fertilizer manufacture. That would be enough gas to heat 500,000 corn-belt homes. Just a few cents' increase in the price of alfalfa — or of natural gas in fertilizer — would do it, he says.

The price of energy is today pegged so low that the cost of replacing fuel we burn is higher than the price we pay. If we paid the true replacement cost — the so-called marginal cost — the practicality of conservation would be thunderous. Some $40 billion of residential improvements would become economic nationwide, saving 2.4 quads (quadrillion B.t.u.s of energy) in 1985; an investment of $126 billion by industry could be justified to its stockholders, saving 10 quads; and 5.5 quads could be saved when commercial building owners found they could save money by investing $45.8 billion in energy efficiency.

Putting these figures together, Roger W. Sant of Carnegie Mellon Research Institute told the A.A.A.S., marginal-cost prices for energy would provide an economic incentive to save nearly 20 quads of energy a year by 1985 — using today's technology. — *J.M.* □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# Visual Information Processing: Artificial Intelligence and the Sensorium of Sight

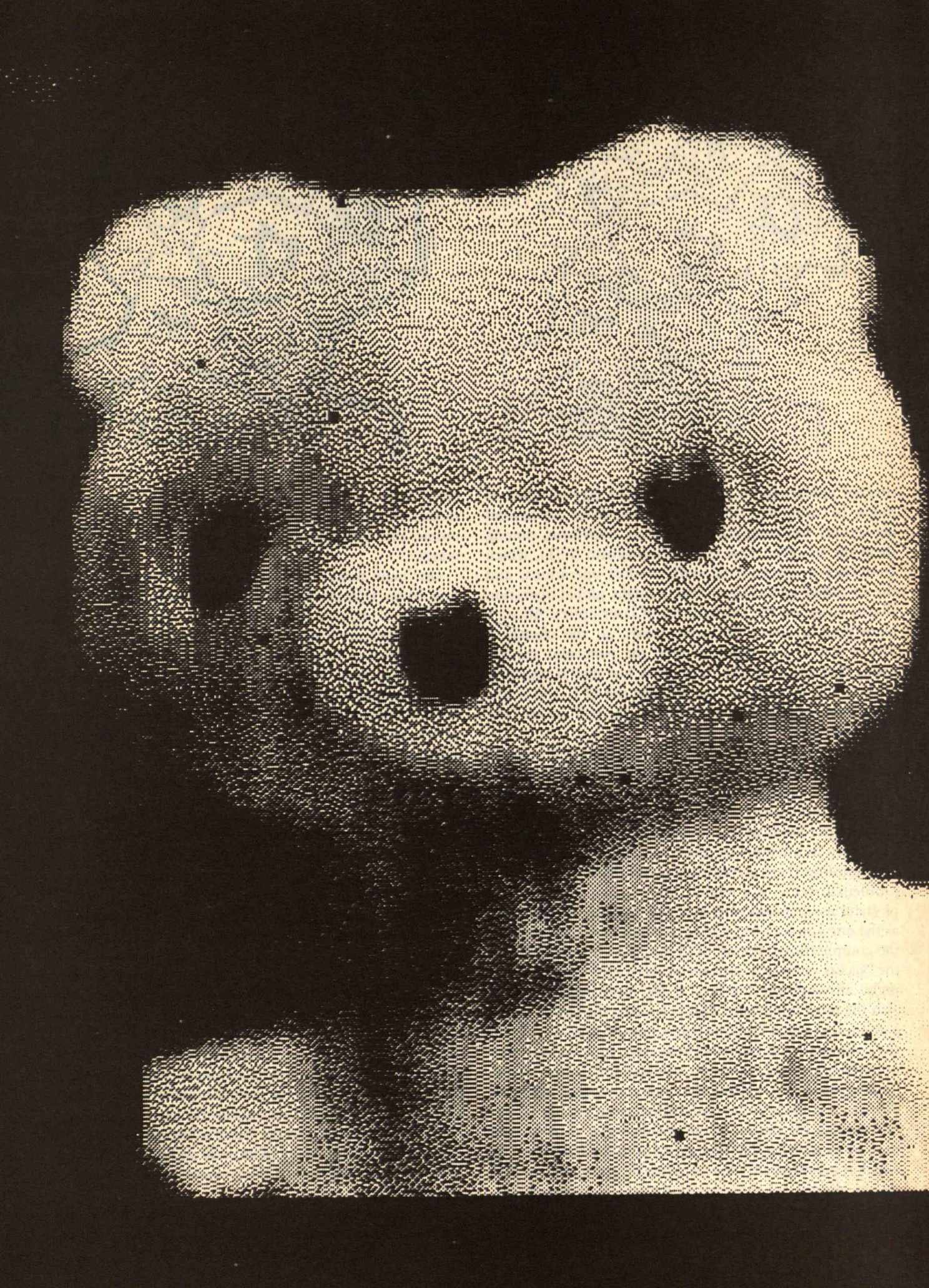
David Marr
H. Keith Nishihara

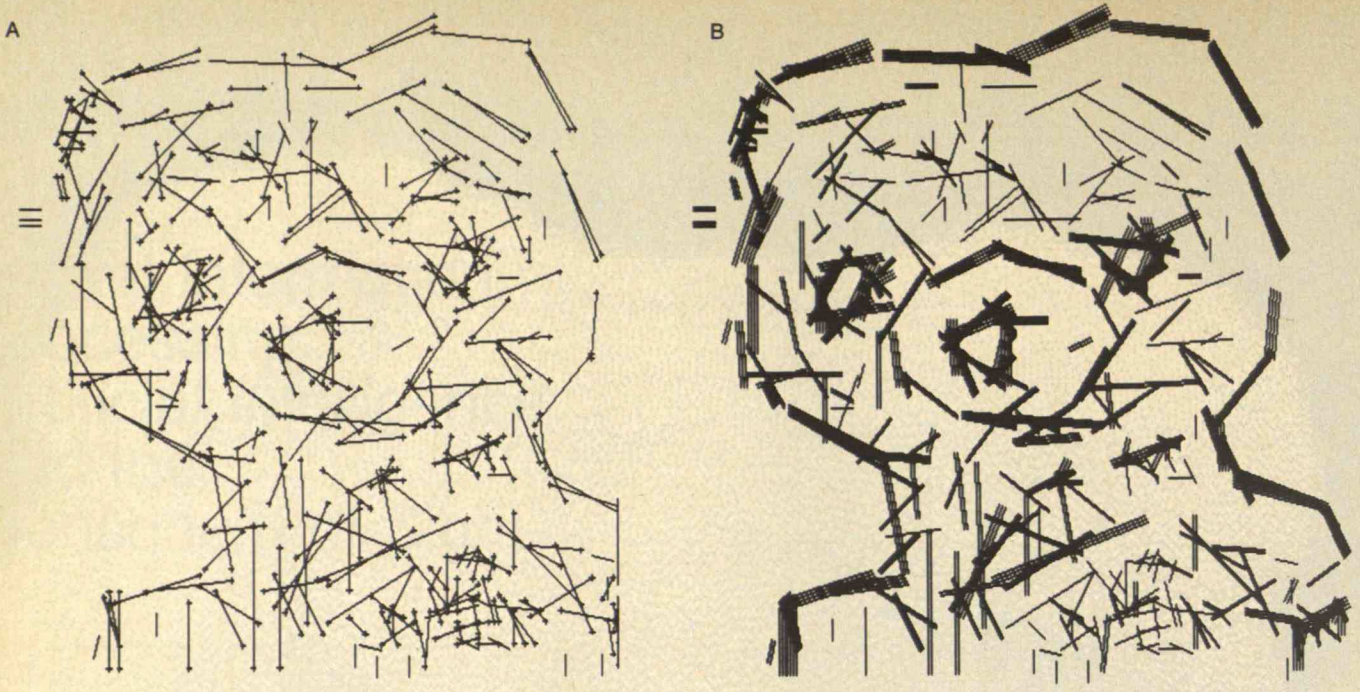
For human vision to be explained by a computational theory, the first question is plain: What are the problems the brain solves when we see?

Modern neurophysiology has learned much about the operation of the individual nerve cell, but unpleasantly little about the meaning of the circuits they compose in the brain. The reason for this can be attributed, at least in part, to a failure to recognize what it means to understand a complex information-processing system; for a complex system cannot be understood as a simple extrapolation from the properties of its elementary components. One does not formulate, for example, a description of thermodynamical effects using a large set of equations, one for each of the particles involved. One describes such effects at their own level, that of an enormous collection of particles, and tries to show that in principle, the microscopic and macroscopic descriptions are consistent with one another.

The core of the problem is that a system as complex as a nervous system or a developing embryo must be analyzed and understood at several different levels. Indeed, in a system that solves an information processing problem, we may distinguish four important levels of description. (We here are following a formulation published in 1977 by Marr and Tomaso Poggio.) At the lowest, there is basic component and circuit analysis — how do transistors (or neurons), diodes (or synapses) work? The second level is the study of particular mechanisms: adders, multipliers, and memories, these being assemblies made from basic components. The third level is that of the algorithm, the scheme for a computation; and the top level contains the *theory* of the computation. A theory of addition, for example, would encompass the meaning of that operation, quite independent of the representation of the numbers to be added — say Arabic versus Roman. But it would also include the realization that the first of these representations is the more suitable of the two. An algorithm, on the other hand, is a particular method by which to add numbers. It therefore applies to a particular representation, since plainly an algorithm that adds Arabic numerals would be useless for Roman. At still a further level down, one comes upon a mechanism for addition — say a pocket calculator — which simply implements a particular algorithm. As a second example, take the case of Fourier analysis. Here the computational theory of the Fourier transform — the decomposition of an arbitrary mathematical curve into a sum of sine waves of differing frequencies — is well understood, and is ex-

The beginning of vision: a gray-level intensity array which will serve to approximate an input to the retina. The processing of such an image by the brain proceeds so naturally — so unconsciously, in a sense — that we are seldom aware that it begins with only this: a two-dimensional play of light upon the receptors of either eye. Our facility suggests the existence of a well-defined computational method, and makes vision a promising field of investigation in artificial intelligence. The image shown here was originally an array of 128 by 128, with each of its elements — numbers, actually — signifying one of 256 possible brightnesses. But the actual image as seen in this magazine is affected by the process by which it first was displayed on the screen of an imaging system resembling the technology of television, then by the processes that copied and printed it, and finally by limitations in human discrimination of brightness. The largest dots in the image are noise in the imaging system: each serves to suggest the actual size of each picture element, or "pixel." Smaller dots are patterns of stippling used in this figure to denote the shades of gray.






pressed independently of the particular way in which it might be computed. One level down, there are several algorithms for computing a Fourier transform, among them the so-called Fast Fourier Transform (FFT), which comprises a sequence of mathematical operations, and the so-called spatial algorithm, a single, global operation that is based on the mechanisms of laser optics. All such algorithms produce the same result, so the choice of which one to use depends upon the particular mechanisms that are available. If one has fast digital memory, adders, and multipliers, one will use the FFT, and if one has a laser and photographic plates, one will use an "optical" method.

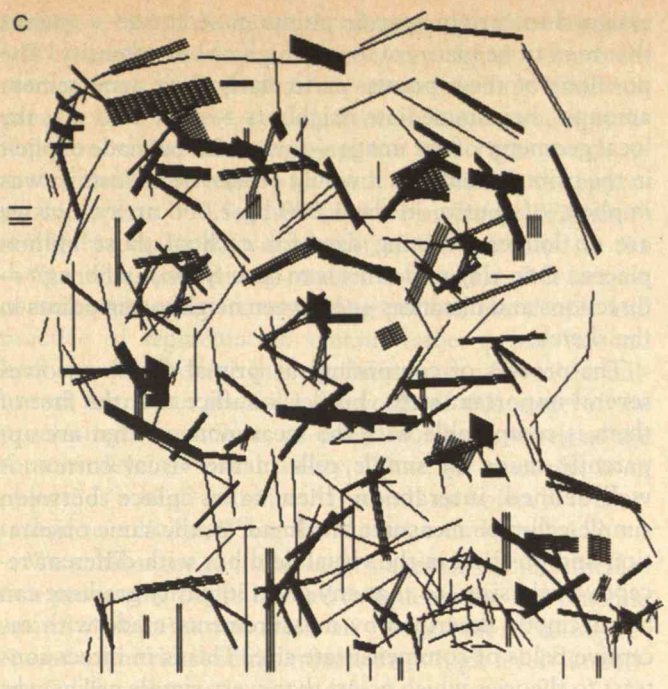
Now each of the four levels of description will have its place in the eventual understanding of perceptual information processing, and of course there are logical and causal relations among them. But the important point is that the four levels of description are only loosely related. Too often in attempts to relate psychophysical problems to physiology there is confusion about the level at which a problem arises — is it related, for instance, mainly to the physical mechanisms of vision (like the after-images such as the one you see after staring at a lightbulb) or mainly to the computational theory of vision (like the ambiguity of the Necker cube as it appears on page 32)? More disturbingly, although the top level is the most neglected, it is also the most important. This is because the nature of the computations that underlie perception depend more upon the computational *problems* that have to be solved than upon the particular hardware in which their solutions are implemented. To phrase the matter another way, an algorithm is likely to be understood more readily by understanding the nature of the problem that it deals with than by examining the mechanism (and the hardware) by which it is embodied. There is, after all, an analog to all of this in physics, where a thermodynamical approach represented, at least historically, the first stage in the study of matter: it succeeded in producing a theory of gross properties such as temperature. A description in terms of mechanisms or elementary components — in this case atoms and molecules — appeared some decades afterwards.

Our main point, therefore, is that the topmost of our four levels, that at which the necessary structure of computation is defined, is a crucial but neglected one. Its study is separate from the study of particular algorithms, mechanisms, or hardware, and the techniques needed to pursue it are new. In the rest of this article, we summarize some examples of vision theories at the uppermost level. We will conclude with some remarks on the development of the field of which these theories are part: the field called artificial intelligence.

### Conventional Approaches

The problems of visual perception have attracted the curiosity of scientists for many centuries. Important early contributions were made by Newton, who laid the foundations for modern work on color vision, and Helmholtz, whose treatise on physiological optics maintains its interest even today. Early in this century, Wertheimer noticed the apparent motion not of individual dots but instead of wholes, or "fields," in images presented sequentially, as if in a movie. In much the same way we perceive the migration across the sky of a flock of geese, the flock somehow constituting a single entity, and not individual birds. This observation started the Gestalt school of psychology, which was concerned with describing the qualities of wholes, including solidarity and distinctness, and trying to formulate the laws that governed their creation. The attempt failed for various reasons, and the Gestalt school dissolved into the fog of subjectivism. With the death of the school, many of its early and genuine insights were unfortunately lost to the mainstream of experimental psychology.

The next developments of importance were recent and technical. The advent of electrophysiology in the 1940s




The so-called primal sketch is shown in three of its aspects; each is a representation of intensity changes in a gray-level image such as appears on page 29. Its creation constitutes the earliest stage in the authors' theory of visual information processing. Sketch A shows only "edge-assertions": each line represents the position and orientation at which a change in intensity is found. The cross-bars at the ends of each line show the terminations of the change. This is not to say that each line necessarily denotes a sharp edge in the gray-level array, but rather that each denotes the existence of a gradient in intensity. Sketch *B* adds information about differing contrasts: each line in *A* is transformed into a set of parallel lines in proportion to the logarithm of the intensity change. In other words, a large magnitude of transition from light to dark or dark to light leads to a bolder edge-assertion. Notice, accordingly, that the margin of the bear tends to have more prominent assertions than those to be found within. In the displays shown here, the spacing between parallel lines in a set is simply proportional to their length. For short assertions, therefore, the multiple lines have tended to overlap, so as to create the impression of a single, thick bar. Sketch *C* shows the fuzziness of each of the edge assertions — that is to say, the widths of the variations in intensity, as opposed to their magnitudes. The thicker sets of lines now tend to lie in the interior of the image, which reflects the circumstance that broad gradients in shading tend not to appear at its edges. As held in computer storage, the primal sketch includes the information shown in *A*, *B*, and *C* alike: that is to say, the positions, directions, magnitudes, and spatial extents of intensity gradients in the gray-level array.

and '50s made single cell recording possible, and with Stephen W. Kuffler's study of retinal ganglion cells — the neurons of the eye that give rise to the optic nerve — a new approach to the problem was born. Its most renowned practitioners are David H. Hubel and Torsten N. Wiesel, who since 1959 have conducted an influential series of investigations on single cell responses at various points along the visual pathway in the cat and the monkey.

Hubel and Wiesel used the notion of a cell's "receptive field" to classify cells in the so-called primary and secondary visual areas of the cerebral cortex into simple, complex, and hypercomplex types. Simple cells are orientation-sensitive and roughly linear. That is to say, the simple cell monitors a particular district of visual space, a so-called receptive field, in this case divided into parallel elongated excitatory and inhibitory parts; events in the first of these promote the cell's electrical activity, events in the second tend to inhibit it; the two opposing phenomena act simultaneously on the cell — in a word, they summate; and finally, a simple cell's response to a stimulating pattern is roughly predictable from its receptive field's geometry. Complex cells, on the other hand, apparently respond to edges and bars over a wider range than a simple cell's field. Hypercomplex cells seem to respond best to points where an edge or bar terminates. How the different types of cell are connected and why they behave as they do is controversial.

Students of the psychology of perception were also affected by a technological advance, the advent of the digital computer. Most notably, it allowed Bela Julesz in 1959 to devise random-dot stereograms, which are image pairs constructed of dot patterns that appear random when viewed monocularly, but which fuse when viewed one through each eye to give a percept of shapes and surfaces with a clear three-dimensional structure. An example is shown on page 35. Here the image for the left eye is a matrix of black and white squares generated at random by a computer program. The image for the right is made by copying the left image and then shifting a square-shaped region at its center slightly to the left, providing a new random pattern to fill in the gap that the shift must create. If each of the eyes sees only one matrix, as if they were both in the same physical place, the result is the sensation of a square floating in space. Plainly such percepts are caused solely by the stereo disparity between matching elements in the images presented to each eye.

Very recently, considerable interest has been attracted by a rather different approach. In 1971, Roger N. Shepard and Jacqueline Metzler made line drawings of simple objects that differed from one another either by a three-dimensional rotation, or by a rotation plus a reflection (see the illustration on page 40). They asked how long it took to decide whether two depicted objects differed by a rotation and a reflection, or merely a rotation. They found that the time taken depended on the 3-D angle of rotation necessary to bring the two objects into correspondence. Indeed, it varied linearly with this angle. One is led thereby to the notion that a mental rotation of sorts is actually being performed: that a mental description of the first shape in a pair is being adjusted incrementally in orientation until it matches the second, such adjustment requiring greater time when greater angles are involved.

Interesting and important though these findings are, one must sometimes be allowed the luxury of pausing to reflect upon the overall trends that they represent, in order to take stock of the kind of knowledge that is accessible through these techniques. For we repeat: perhaps the most striking feature of neurophysiology and psychophysics at present is that they *describe* the behavior of cells or of subjects, but do not *explain* it. What are the visual areas of the cerebral cortex actually doing? What are the problems in doing it that need explaining, and at what level of description should such explanations be sought?

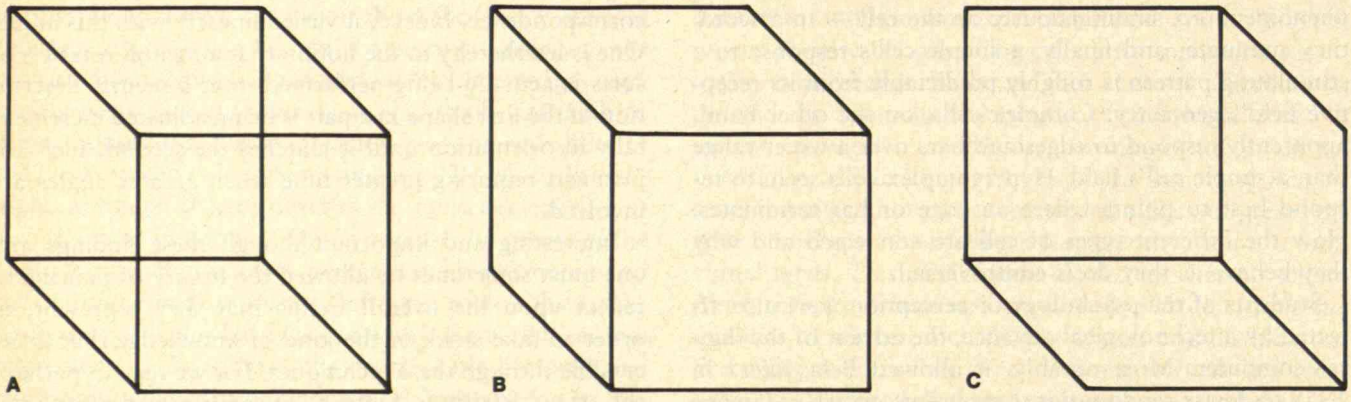
## A Computational Approach to Vision

In trying to come to grips with these problems, our group at the M.I.T. Artificial Intelligence Laboratory has adopted a point of view that regards visual perception as a problem primarily in information processing. The problem commences with a large, gray-level intensity array, which suffices to approximate an image such as the world might cast upon the retinas of the eyes (an example appears on page 29), and it culminates in a *description* that depends on that array, and on the purpose that the viewer brings to it. Our particular concern in this article will be with a description well suited for the recognition of three-dimensional shapes.

*The Primal Sketch.* It is a commonplace that a scene and a drawing of the scene appear very similar, despite the completely different gray-level images to which they give rise. This suggests that the artist's symbols correspond in some way to natural symbols that are computed out of the image during the normal course of its interpretation. Our theory therefore asserts that the first operation on an image is to transform it into a primitive but rich description of the way its intensities change over the visual field, as opposed to a description of its particular intensity values in and of themselves. This yields a description of markedly reduced size that still captures the important aspects required for image analysis. We call it a *primal sketch.* Consider, for example, an intensity array of 1,000 by 1,000, or a million points in all. Even if the possible intensity at any one point were merely black or white — two different brightnesses — the number of all possible arrays would still be $2^{1,000,000}$. In a real image, however, there tend to be continuities of intensity — areas where brightness varies uniformly — and this tends to eliminate possibilities in which the black and white oscillate wildly. It also tends to simplify the array. Typically, therefore, a primal sketch need not include a set of values for every point in an image. As stored in a computer, it will instead constitute an array with numbers representing the directions, magnitudes, and spatial extents of intensity changes assigned to certain specific points in an image — points that tend to be places of locally high or low intensity. The positions of these points, particularly their arrangement amongst their immediate neighbors — that is to say, the local geometry of the image — must also be made explicit in the primal sketch, as it would otherwise be lost. (It was implicit, of course, in the 1,000-by-1,000 array, but we are no longer retaining data for each of those million places.) One way to do this is to specify "virtual lines" — directions and distances — between neighboring points in the sketch.

The process of computing the primal sketch involves several important steps, but let it suffice that the first of them is comparable with the measurements that are apparently made by simple cells in the visual cortex. A well-defined interaction then takes place between simple-cell-type measurements made at the same orientation and position in the visual field but with different receptive field sizes, so that any given intensity gradient can be succinctly described by measurements made with receptive fields of commensurate size. This is in direct contrast to theories which assert that every simple cell acts as a "feature detector" whose output is freely available to subsequent processes.

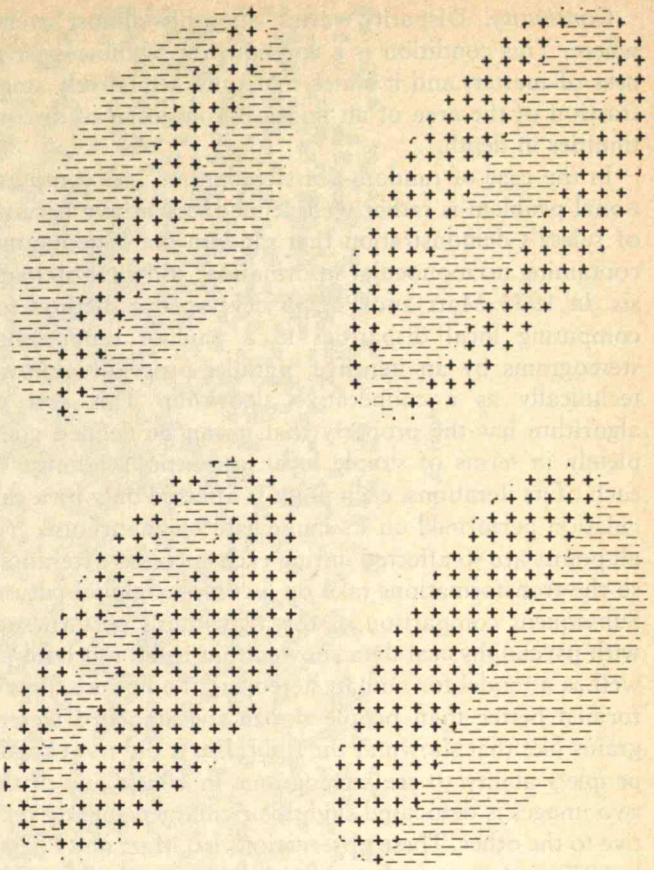
*Modules of Early Visual Processing.* The primal sketch of an image is typically a large and unwieldy collection of data, even despite its simplification relative to a gray-level array; for this is the unavoidable consequence of the irregularity and complexity of natural images. The next computational problem is thus its decoding. Now the traditional approach to machine vision assumes that the essence of such a decoding is a process called *segmentation,* whose purpose is to divide a primal sketch, or more generally an image, into regions that are meaningful, perhaps as physical objects. Tenenbaum and Barrow, for example, applied knowledge about several different types of scene to the segmentation of images of landscapes, an office, a room, and a compressor. Freuder used a similar approach to identify a hammer in a simple scene. Upon




The so-called Necker illusion, named after L. A. Necker, the Swiss naturalist who developed it in 1832. The essence of the matter is that the two-dimensional representation which appears as part (a) of the figure has collapsed the depth out of a cube, and that a certain aspect of human vision is thus to recover this missing third dimension. It develops that the depth of the cube (or rather in its image) can indeed be perceived, but only to the extent that two interpretations are possible: the two shown as (b) and (c). Your perception of (a) characteristically "flips" from one to the other. Understanding why this should be so is a part of devising a computational theory of vision. By contrast, the understanding of the afterimage that you see when you stare at a lightbulb seems simply to be a matter of understanding the characteristics of the visual "hardware" — in this instance, that a sustained stimulus will fatigue the light-receptive cells of the retina.

finding a blob, his computer program would tentatively label it as the head of a hammer, and begin a search for confirmation in the form of an appended shaft. If this approach were correct, it would mean that a central problem for vision is arranging for the right piece of specialized knowledge to be made available at the appropriate time in the segmentation of an image. Freuder's work, for example, was almost entirely devoted to the design of a system that made this possible. But despite considerable efforts over a long period, the theory and practice of segmentation remain rather primitive, and here again we believe that the main reason lies in the failure to formulate precisely the goals of this stage of the processing — a failure, in other words, to work at the topmost level of visual theory. What, for example, is an object? Is a head an object? Is it still an object if it is attached to a body? What about a man on horseback?

We shall argue that the early stages of visual information processing ought instead to squeeze the last possible ounce of information from an image before taking recourse to the descending influence of "high-level" knowledge about objects in the world. Let us turn, then, to a brief examination of the physics of the situation. As we noted earlier, the visual process begins with arrays of intensities projected upon the retinas of the eyes. The principal factors that determine these intensities are (1) the illuminant, (2) the surface reflectance properties of the objects viewed, (3) the shapes of the visible surfaces of these objects, and (4) the vantage point of the viewer. Thus if the analysis of the input intensity arrays is to operate autonomously, at least in its early stages, it can only be expected to extract information about these four factors. In short, early visual processing must be limited to the recovery of localized physical properties of the visible *surfaces* of a viewed object — particularly local surface dispositions (orientation and depth) and surface material properties (color, texture, shininess, and so on). More abstract matters such as a description of overall three-dimensional shape must come after this more basic analysis is complete.



Four examples of "receptive fields" for so-called simple cells of the primary visual cortex. Each field circumscribes the part of the world that is monitored, so to speak, by the cell. But within that locus are bands in which the appearance of light will excite the neuron's ongoing electrical activity (plus signs) and parallel bands that inhibit it (minus signs). The best possible stimulus for the fourth of these examples is a sharp edge in an image with brightness at the left and darkness at the right; for the shining of light on the right-hand side of the receptive field would inhibit, not excite, the associated neuron.

An example of early processing is stereopsis. Imagine that images of a scene are available from two nearby points at the same horizontal level — the analog of the images that play upon the retinas of your left and right eyes. The images are somewhat different, of course, in consequence of the slight difference in vantage. Imagine further that a particular location on a surface in the scene is chosen from one image; that the corresponding location is identified in the other image; and that the relative positions of the two versions of that location are measured. This information will suffice for the calculation of depth — the distance of that location from the viewer. Notice that methods based on gray-level correlation between the pair of images fail to be suitable because a mere gray-level measurement does not reliably define a point on a physical surface. To put the matter plainly, numerous points in a surface might fortuitously be the same shade of gray, and differences in the vantage points of the observer's eyes could change the shade as well. The matching must evidently be based instead on objective markings that lie upon the surface, and so one has to use changes in reflectance. One way of doing this is to obtain a primitive description of the intensity changes that exist in each image (such as a primal sketch), and then to match these descriptions. After all, the line segments, edge segments, blobs, and edge termination points included in such a description correspond quite closely to boundaries and reflectance changes on physical surfaces. The stereo problem — the determination of depth given a stereo pair of images — may thus be reduced to that of matching two primitive descriptions, one from each eye; and to help in this task there are physical constraints that translate into two rules for how the left and right descriptions are combined:

*Uniqueness.* Each item from each image may be assigned at most one disparity value — that is to say, a unique position relative to its counterpart in the stereo pair. This condition rests on the premise that the items to be matched have a physical existence, and can be in only one place at a time.

*Continuity.* Disparity varies smoothly almost everywhere. This condition is a consequence of the cohesiveness of matter, and it states that only a relatively small fraction of the area of an image is composed of discontinuities in depth.

In the case of random-dot stereograms, the computational problem is rather well-defined, essentially because of Julesz's demonstration that random-dot stereograms, containing no monocular information, still yield stereopsis. In 1976 Marr and Poggio developed a method for computing local disparities in a pair of random-dot stereograms by an iterative, parallel procedure known technically as a cooperative algorithm. This sort of algorithm has the property that it can be defined completely in terms of simple local interactions because at each of its iterations, each point is affected only by a calculation performed on its immediate neighborhood. Yet all points are so affected during each successive iteration, so the transformations take on a complex global nature. Subsequent comparison of the algorithm's performance with psychophysical data showed that it did not hold up well as a model for human stereopsis. To be sure, it performed better than people do on the standard stereograms like that shown at the right; but it did not explain people's ability to see stereograms in which one of the two images is defocused slightly or enlarged slightly relative to the other. These observations led Marr and Poggio in 1977 to devise another algorithm, this one based on the human use of so-called vergence eye movements, in which the two eyes cross to a greater or lesser extent without changing their average direction of view. This algorithm is consistent with all of the currently known psychophysical data.

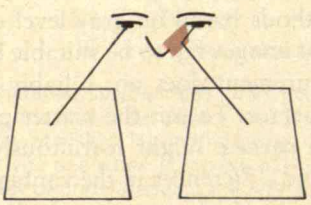
A second example of early visual processing concerns the derivation of structure from motion. It has long been known that as an object moves relative to the viewer, the way its appearance changes provides information that we use to determine its shape. The problem decomposes into two parts: matching the elements that occur in consecutive images; and deriving shape information from measurements of their changes in position. Shimon Ullman has shown that these problems can be solved mathematically. His idea is that in general, nothing can be inferred about the shape of an object given only a set of sequential views of it; for some extra assumptions have to be made. Accordingly, he formulates an assumption of rigidity, which states that if a set of moving points has a *unique* interpretation as a rigid body in motion, that interpretation is correct. (The assumption is based on a theorem which he proves, stating that three distinct views of four non-coplanar points on a rigid body are sufficient to determine uniquely their three-dimensional arrangement in space.) From this he derives a method for computing structure from motion. The method gives results that are quantitatively superior to the ability of humans to determine shape from motion, and which fail in qualitatively similar circumstances. Ullman has also devised a set of simple algorithms by which the method may be implemented.

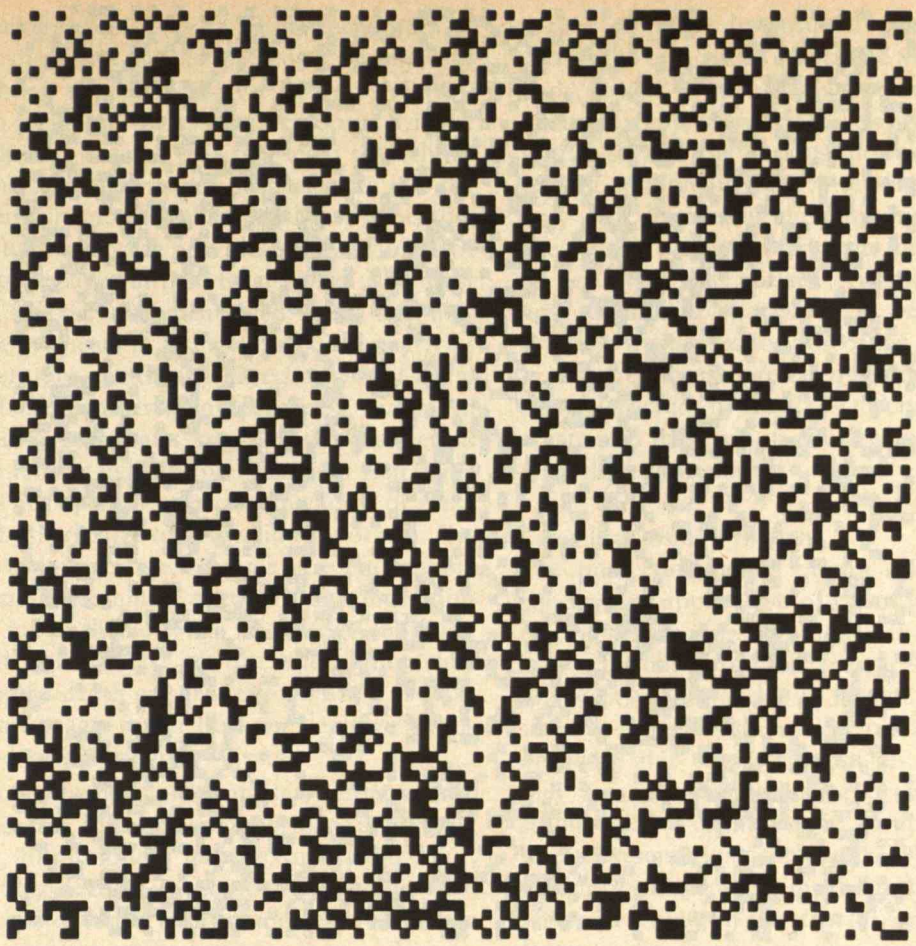
*(Text resumes on page 37.)*

## Recovering the Depth of the Three Dimensional World

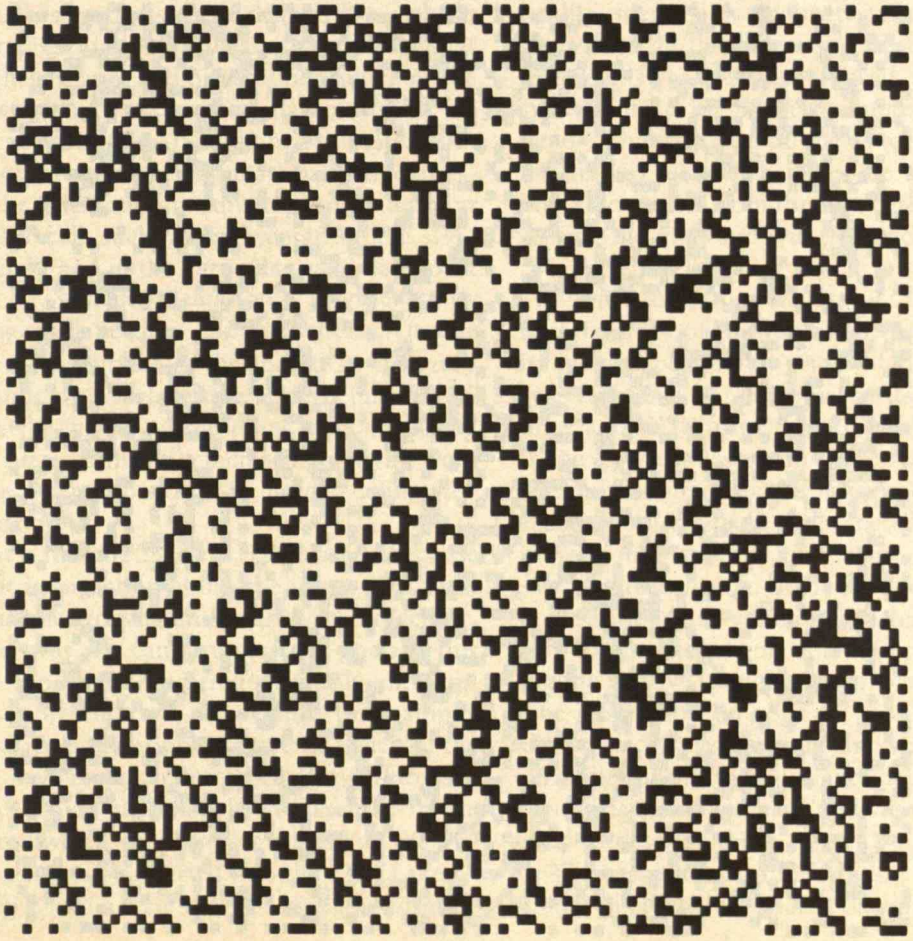
The following pages provide two pairs of so-called random-dot stereograms as developed at Bell Telephone Laboratories by Bela Julesz. The reader is urged to experiment with them; all that you need, in addition to the images themselves, is a hand mirror that you can hold against either side of your nose. First an explanation: Hold your thumb at various distances from your eyes against a more distant background. Closing first one eye and then the other will then convince you that objects in the world have somewhat different positions in the images that the world casts upon each of your retinas. (The magnitude of the difference is inversely proportional to the distance of the object.) The point of the stereo pair is to show that such disparities are sufficient for your brain to recover the lost third dimension from such two-dimensional images (except for a small percentage of people who lack stereo vision). After all, each of the patterns printed on subsequent pages shows nothing recognizable. Each is a computer-generated assembly of black and white picture-elements ("pixels"). The pair labelled A, however, have a square-shaped region shifted in one of the images several pixels relative to its placement in the other. In short, then, the stereo pair contains *no information whatever about visible surfaces* — except for left-right disparities of the aforementioned sort.

Will this be sufficient for 3-D perception? First of all, cut out the images. Place the pair labelled A on a table-top with a few inches between them. Adhere to "left" and "right" as printed beneath the arrays. Position your head a foot or more above them. Hold the mirror with its back against the left side of your nose, in such a way that your right eye looks directly at the right member of the pair, but your left eye sees the mirror reflection of the left. By suitable maneuvering of the images, your head, and the mirror, get the left and right images to appear to be in the same place — in a word, to coincide. (They would coincide, too, if they were placed in a stereo viewer, but these images have been designed to be used with a mirror, and thus take account of a mirror reflection. They therefore won't work in a stereo viewer.) A few minutes of trying are likely to be required before the image-fusion occurs. Try to relax, and not to strain your eyes. If you achieve stereopsis, there will be no mistaking the effect: it is a striking one. With the mirror reflecting the left image into your left eye, your perception is of a square floating in space above the plane of the background. With the mirror reflecting the right image into the right eye (or alternatively by turning both images upside-down and keeping the mirror as before), the square floats behind. (Many people find this harder to see.) For the effect involving the left-right pair labelled B, consult the illustration and caption on page 38. We wish to express our appreciation to Bela Julesz for the suggestion that a mirror might be used in place of more complicated apparatus to achieve stereopsis.

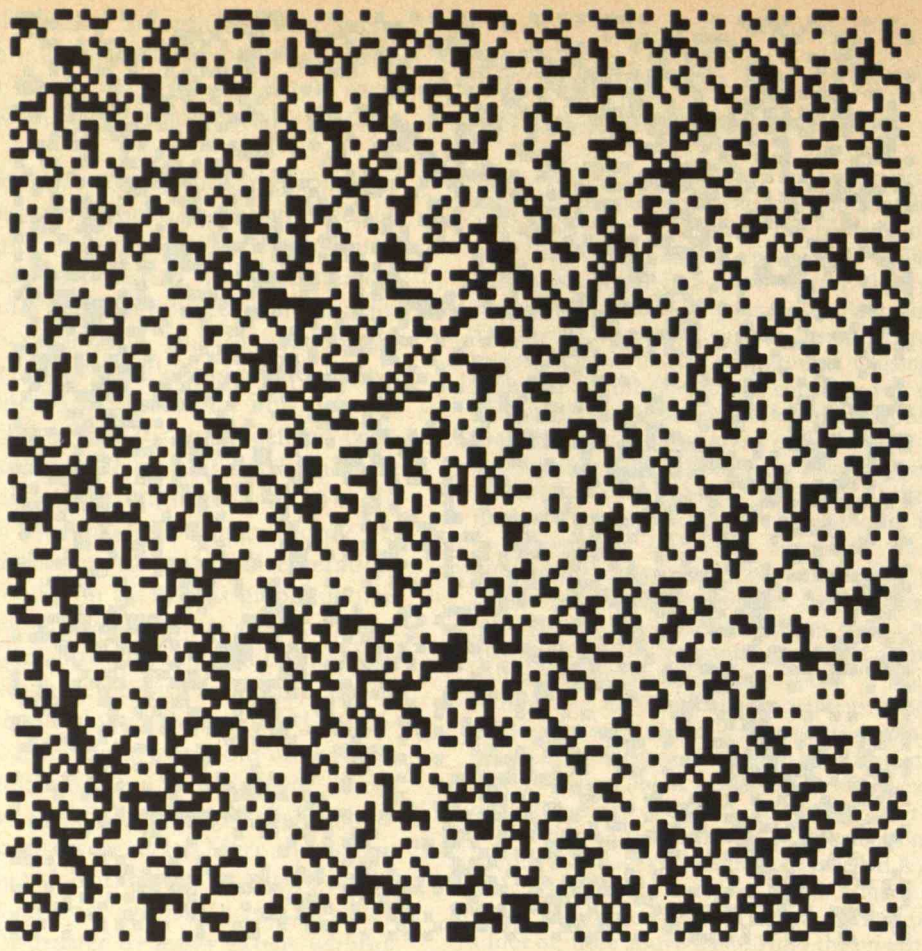




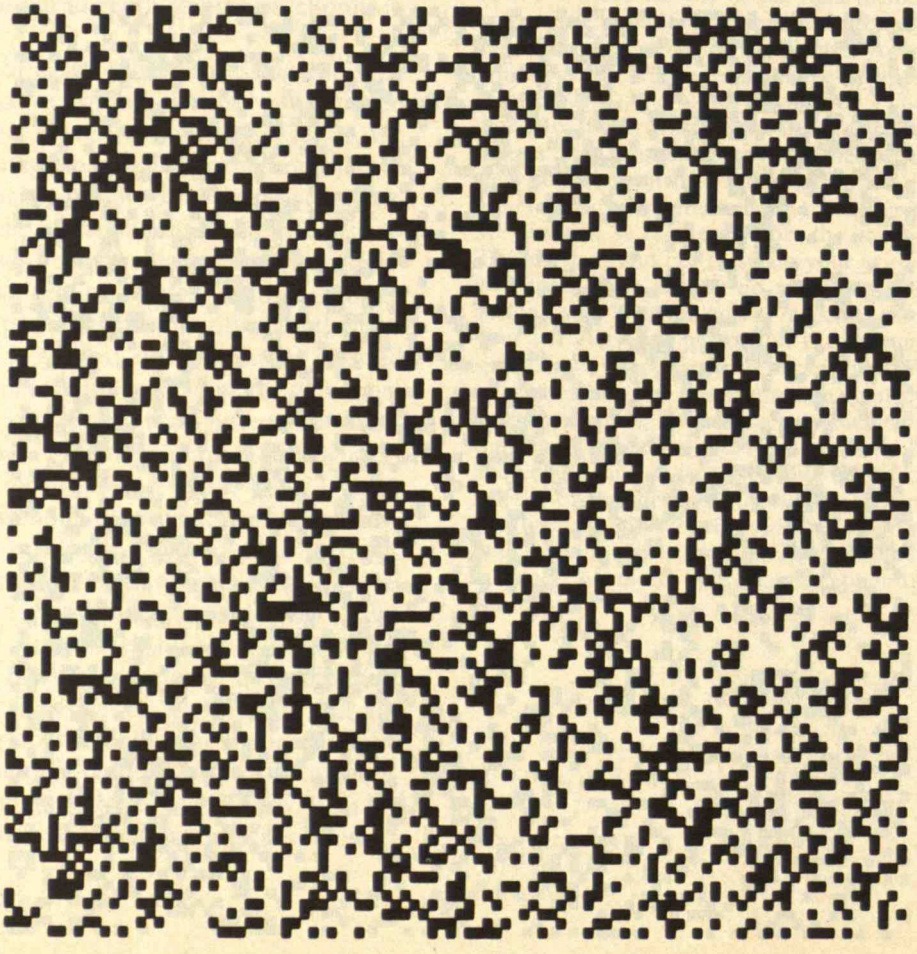
Pair A: Right



Pair A: Left



Pair B: Left



Pair B: Right

*The 2½-Dimensional Sketch.* Both of the techniques of image analysis discussed in the preceding paragraphs provide information about the relative distances to various places in an image. In the case of stereopsis, it is the matching of points in a stereo pair that leads to such information. In the case of structure from motion, it is the matching of points in successive images. More generally, however, we know that vision provides several sources of information about shapes in the visual world. The most direct, perhaps, are the aforementioned stereo and motion, but texture gradients in a single image are nearly as effective. Furthermore, the theatrical techniques of facial make-up reveal the sensitivity of perceived shapes to shading, and color sometimes suggests the manner in which a surface reflects light. It often happens that some parts of a scene are open to inspection by some of these techniques, and other parts to inspection by others. Yet different as the techniques are, they all have two important characteristics in common: they rely on information from the image rather than *a priori* knowledge about the shapes of the viewed objects; and the information they specify concerns the depth or surface orientation at arbitrary points in an image, rather than the depth or orientation associated with particular objects.

In order to make the most efficient use of different and often complementary channels of information deriving from stereopsis, from motion, from texture, from color, from shading, they need to be combined in some way. The computational question that now arises is thus how best to do this, and the natural answer is to seek some representation of the visual scene that makes explicit just the information these processes can deliver. We seek, in other words, a representation of surfaces in an image that makes explicit their shapes and orientations, much as the Arabic representation of a number makes explicit its composition by powers of ten. It might be contrasted with the representation of a surface as a mathematical expression, in which the orientation is only implicit, and not at all apparent. We call such a representation the 2½-dimensional sketch, and in the particular candidate for it shown on page 41, surface orientation is represented by covering an image with needles. The length of each needle defines the dip of the surface at that point, so that zero length corresponds to a surface that is perpendicular to the vector from the viewer to the point, and increasing lengths denote surfaces that tilt increasingly away from the viewer. The orientation of each needle defines the local direction of dip.

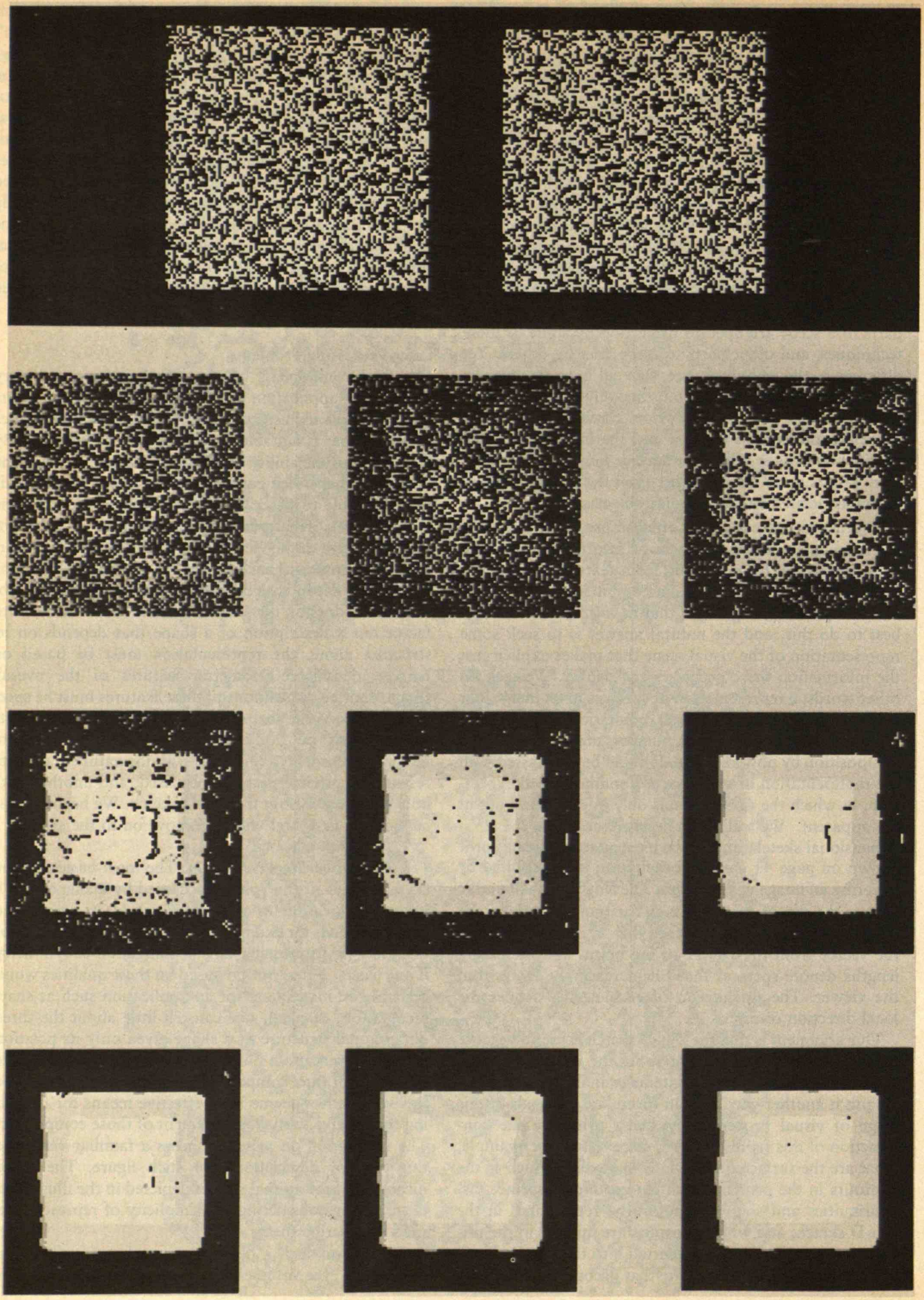
Our argument is that the 2½-D sketch is useful because it makes explicit information about the image in a form that is closely matched to what image analysis can deliver. To put it another way, we can formulate the goals of this stage of visual processing as being primarily the construction of this representation, discovering, for example, what are the surface orientations in a scene, which of the contours in the primal sketch correspond to surface discontinuities and should therefore be represented in the 2½-D sketch, and which contours are missing in the primal sketch and need to be inserted into the 2½-D sketch in order to bring it into a state that is consistent with the nature of three-dimensional space. This formulation avoids the difficulties associated with the terms "region" and "object" — the difficulties inherent in the image segmentation approach; for the gray level intensity array, the primal sketch, the various modules of early visual processing, and finally the 2½-dimensional sketch itself deal only with discovering the properties of *surfaces* in an image. One is pleased about that, for we know of ourselves as perceivers that surface orientation can be associated with unfamiliar shapes, so its representation probably precedes the decomposition of the scene into objects. One is thus free to ask precise questions about the computational structure of the 2½-D sketch and of processes to create and maintain it. We are currently much occupied with these matters.

**Later Processing Problems**

The final components of our visual processing theory concern the application of visually derived surface information for the representation of three-dimensional shapes in a way that is suitable specifically for recognition. By this we mean the ability to recognize a shape as being the same as a shape seen earlier, and this in essence depends on being able to describe shapes consistently each time they are seen, whatever the circumstances of their positions relative to the viewer. The problem with local surface representations such as the 2½-D sketch is that the description depends as much on the viewpoint of the observer as it does on the structure of the shape. In order to factor out a description of a shape that depends on its structure alone, the representation must be based on readily identifiable geometric features of the overall shape, and the dispositions of these features must be specified relative to the shape in itself. In brief, the coordinate system must be "object-centered," not "viewer-centered." One aspect of this deals with the nature of the representation scheme that is to be used, and another with how to obtain it from the 2½-D sketch. We begin by discussing the first, and will then move on to the second.

*The 3-D Model Representation.* The most basic geometric properties of the volume occupied by a shape are (1) its average location (or center of mass); (2) its overall size, as exemplified, for example, by its mean diameter or volume; and (3) its principal axis of elongation or symmetry, if one exists. A description based on these qualities would certainly be inadequate for an application such as shape recognition; after all, one can tell little about the three-dimensional structure of a shape given only its position, size, and orientation. But if a shape itself has a natural decomposition into components that can be so described, this volumetric scheme is an effective means for describing the relative spatial arrangement of those components. The illustration on page 43 shows a familiar version of this type of description, the stick figure. The recognizability of the animal shapes depicted in the illustration is surprising considering the simplicity of representation used to describe them.

The reason such a description works so well lies, we think, in (1) the volumetric (as opposed to surface-based)



definition of the primitive elements — the sticks — used by the representation; (2) the relatively small number of elements used; and (3) the relation of elements to each other rather than to the viewer. In short, this type of shape representation is volumetric, modular, and can be based on object-centered coordinates. The figure on page 44 illustrates the scheme of representation that was developed from these ideas. Here the description of a shape is composed of a hierarchy of stick-figure specifications we call 3-D models. In the simplest, a single axis element is used to specify the location, size, and orientation of the entire shape; the human body displayed in the illustration will serve as an instance. This element is also used to define a coordinate system that will specify the dispositions of subsidiary axes, each of these specifying in turn a coordinate system for 3-D models of "arm," "hand," and so on. This hierarchical structure makes it possible to treat any component of a shape as a shape in itself. It also provides flexibility in the detail of a description.

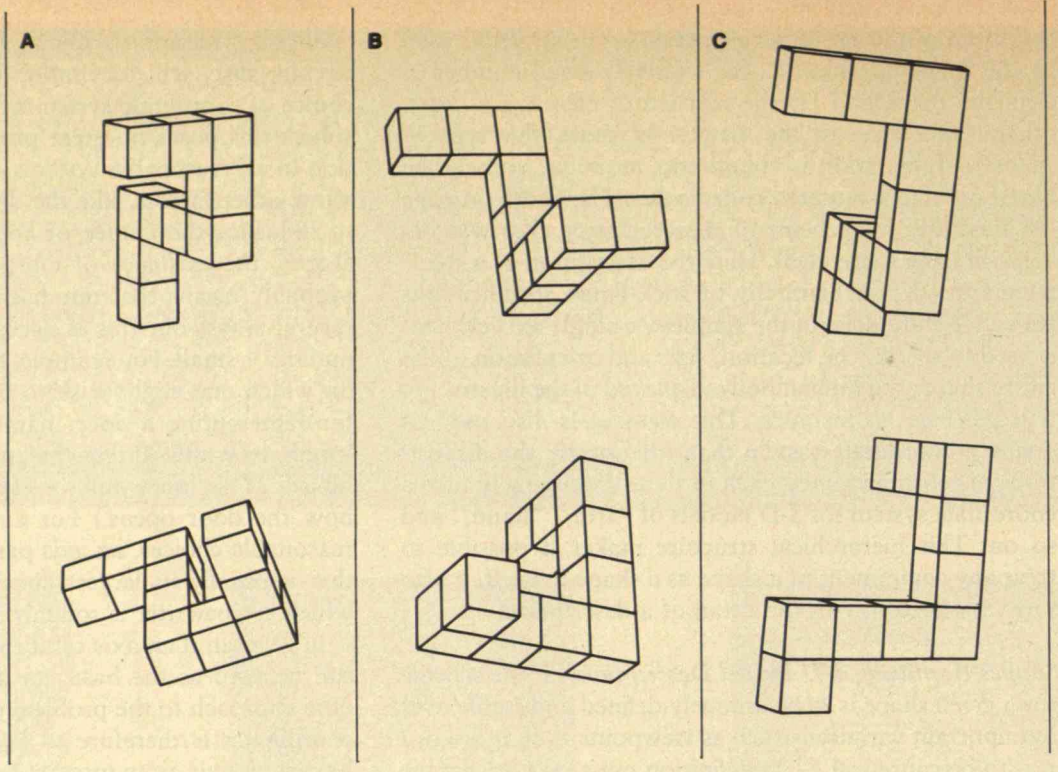
*Shapes Admitting 3-D Model Descriptions.* If the scheme for a given shape is to be uniquely defined and stable over unimportant variations such as viewpoint — if, in a word it is to be canonical — its definition must take advantage of any salient geometrical characteristics that the shape inherently possesses. If a shape has natural axes, then those should be used. The coordinate system for a sausage should take advantage of its major axis, and for a face, of its axis of symmetry.

The decoding of a random-dot stereogram pair, as performed by an algorithm devised by David Marr and Tomaso Poggio in 1976. The nature of the problem is to determine which point in one image is a match to any given point in the other. (Remember that the same surface markings have differing placements in the images cast upon either retina.) After that, a depth can be assigned for any given stereo disparity. The algorithm begins by creating a series of parallel planes to represent possible depths — that is to say, possible distances of various surfaces from the viewer. It then marks this three-dimensional matrix to indicate each location where a local patch of surface could conceivably lie, based on varying construals of the patterns of picture elements in the stereo pair. To phrase it another way, any given pixel in one stereogram is temporarily assumed to match with any of a number of candidate pixels in the other, within a limit of wide angular differences. At this stage, a pair of conditions are applied to each mark in the array thus created: first, that only a single match for any one point in either stereogram will ultimately be accepted; and second, that real 3-D surfaces tend to be continuous in depth. More particularly, at each iteration of the processing that now takes place, the number of marks at a given position but various depths is compared with the number of marks that lie nearby at similar depth. The more of the former, the more likely it is that the mark is incorrectly placed. The more of the latter, the more likely it is that its placement is correct. Thus a weighting of these two factors determines if the mark will be preserved to the next iteration. The illustration shows the original stereo pair, the original matrix computed therefrom, and also the results after one, two, three, four, five, six, eight, and fourteen iterations. Shades of gray are employed to signify marks at greater or lesser depths in the 3-D matrix. The algorithm therefore progressively reveals a nested set of tiers — the pattern, in essence, of a rectangular wedding cake. The reader who succeeds in achieving stereopsis with stereo pair B (printed on page 36 of this article) will see the actual effect that the algorithm here uncovers. It turns out that the algorithm fails under conditions in which human vision is known to succeed — for example, a slight defocusing of the left or right stereogram. In 1977, Marr and Poggio devised a second algorithm, based on different principles, that closely matches human abilities.

Highly symmetrical objects, like a sphere, a square, or a circular disc, will inevitably lead to ambiguities in the choice of coordinate systems. For a shape as regular as a sphere this poses no great problem, because its description in all reasonable systems is the same. One can even allow other factors, like the direction of motion or spin, to influence the choice of coordinate frame. For other shapes, the existence of more than one possible choice probably means that one has to represent the object in several ways, but this is acceptable provided that their number is small. For example, there are four possible axes on which one might wish to base the coordinate system for representing a door, namely the midlines along its length, its width, and its thickness, and also the axis of its hinges. (This last would be especially useful to represent how the door opens.) For a typewriter, there are two reasonable choices, an axis parallel to its width, because that is usually its largest dimension, and the axis about which a typewriter is roughly symmetrical.

In general, if an axis can be distinguished in a shape, it can be used as the basis for a local coordinate system. One approach to the problem of defining object-centered coordinates is therefore to examine the class of shapes having an axis as an integral part of their structure. Consider, accordingly, the class of so-called *generalized cones,* each of these being the surface swept out by moving a cross-section of constant shape but smoothly varying size along an axis, as shown on page 46. Thomas O. Binford has drawn attention to this class of constructions, suggesting that it might provide a convenient way of describing three-dimensional surfaces for the purposes of computer vision. We regard it as an important class not because the shapes themselves are easily describable, but because the presence of an axis allows one to define a canonical local coordinate system. Fortunately, many objects, especially those whose shape was achieved by growth, are described quite naturally in terms of one or more generalized cones. The animal shapes on page 43 provide some examples; the individual sticks are simply the axes of generalized cones that approximate the shapes of parts of these creatures. Many artifacts can also be described in this way — say a car (a small box sitting atop a longer one) or a building (a box with a vertical axis).

It is perhaps worth mentioning the following curious point that has emerged from this way of representing three-dimensional shapes. In 1973 Warrington and Taylor described patients with right parietal lobe lesions (that is to say, damage to a particular part of the cerebral cortex) who had difficulty in recognizing objects seen in "unconventional" views, such as the view of a water pail seen from above in the figure on page 45. The researchers did not attempt to define what makes a view "unconventional." But according to our theory, the most troublesome views of an object will likely be those in which its intrinsic coordinate axes cannot easily be recovered from the image. Our theory therefore predicts that unconventional views in the Warrington and Taylor sense will correspond to those views in which an important axis in the object's 3-D model representation is foreshortened. Such views are by no means uncommon. If a 35mm camera is




Some drawings similar to those used in Shepard and Metzler's 1971 experiments on mental rotation. The ones shown in (A) are identical, as a clockwise turning of this magazine by 80 degrees will readily prove. Those in (B) are also identical, and again the relative angle between the two is 80 degrees. Here, however, it is a rotation in depth that will make the first coincide with the second. Finally, those in (C) are not at all identical, for no rotation will bring them into congruence. The time taken to decide whether a pair is the same was found to vary linearly with the angle through which one figure must be rotated to be brought into correspondence with the other. This suggested to the investigators that a stepwise mental rotation was in fact being performed by the subjects of their experiments.

directed towards you, you are seeing an unconventional view of it, since the axis of its lens is foreshortened.

It is important to remember, however, that there exist surfaces that cannot conveniently be approximated by generalized cones, for example a cake that has been transected at some arbitrary plane, or the surface formed by a crumpled newspaper. Cases like the cake could be dealt with by introducing a suitable surface primitive for describing the plane of the cut, in much the same way as an axis in the 3-D model representation is a primitive that describes a volumetric element. But the crumpled newspaper poses apparently intractable problems.

*Finding the Natural Coordinate System.* Even if a shape possesses a canonical coordinate frame, one still is faced with the problem of finding it from an image. Our own interest in this problem grew from the question of how to interpret the *outlines* of objects as seen in a two-dimensional image, and our starting point was the observation that when one looks at the silhouettes in Picasso's "Rites of Spring" (reproduced here on page 48), one perceives them in terms of very particular three-dimensional shapes, some familiar, some less so. This is quite remarkable, because the silhouettes could in theory have been generated by an infinite variety of three-dimensional shapes which, from other viewpoints, would have no discernible similarities to the shapes we perceive. One can perhaps attribute part of the phenomenon to a familiarity with the depicted shapes, but not all of it, because one can use the medium of a silhouette to convey a new shape, and because even with considerable effort it is difficult to imagine the more bizarre three-dimensional surfaces that could have given rise to the same silhouettes. The paradox, then, is that the bounding contours in Picasso's "Rites" apparently tell us more than they should about the shape of the figures. For example, neighboring points on such a contour could in general arise from widely separated points on the original surface, but our perceptual interpretation usually ignores this possibility.

The first observation to be made is that the contours that bound these silhouettes are contours of surface discontinuity, which are precisely the contours with which the 2½-D sketch is concerned. Secondly, because we can interpret the silhouettes as three-dimensional shapes, then implicit in the way we interpret them must lie some *a priori* assumptions that allow us to infer a shape from an outline. If a surface violates these assumptions, our analysis will be wrong, in the sense that the shape we assign to the contours will differ from the shape that actually caused them. An everyday example is the shadowgraph, where the appropriate arrangement of one's hands can, to the surprise and delight of a child, produce the shadow of a duck or a rabbit.

What assumptions is it reasonable to suppose that we make? In order to explain them, we need to define the four constructions that appear in the figure on page 47. These are (1) a three-dimensional surface $\Sigma$; (2) its image or silhouette $S_V$ as seen from a viewpoint $V$; (3) the bounding contour $C_V$ of $S_V$; and (4) the set of points on the surface $\Sigma$ that project onto the contour $C_V$. We shall call this last the *contour generator* of $C_V$, and we shall denote it by $\Gamma_V$.

Observe that the contour $C_V$, like the contours in the work of Picasso, imparts very little information about the three-dimensional surface that caused it. Indeed, the only obvious feature available in the contour is the distinction between convex and concave places — that is to say, the presence of inflection points. In order that these inflections be "reliable," one needs to make some assumptions about the way the contour was generated, and we choose the following restrictions:

# MIT '79

## Articles



## Departments



## "What They Get (and They Like It) Is an Education That Helps Them with Problem-Solving . . ."

The ritual is experienced every year by the city of Cambridge — its ambience is suddenly radically changed from empty, quiet, listless, hot summer months to bustling, chaotic new life and energy. Hundreds of students descend, dragging suitcases, books, backpacks — surely the whole world is moving.

For many, it's a homecoming.

For some — a little over 1,000 at M.I.T. — it's the beginning of something unknown, much touted, somewhat feared, greatly anticipated, and certainly deemed "important." That it is.

For Carola Eisenberg, M.D., former Dean for Student Affairs, it was a time to meet what she calls "exciting human beings, enormously energetic, creative, dedicated learners, bright, goal-oriented, community-oriented. . ."

She has left her role of Dean now, after six years, to become Dean of Student Affairs at Harvard Medical School. "There are times for beginnings and times for endings," she wrote to the student newspapers, "The times for endings are at the peak: when affairs are going well, when enthusiasm is still high and when memories are fond."

Her vantage point gave her special insights into students at M.I.T. — their problems, their strengths, their potential.

Some of her observations:

On freshmen and Freshman Week: "It is exhilarating and exhausting — some students are overwhelmed by it. They don't have a definite place to live when they arrive. We could make that choice ahead of time, but allowing them their own selection process makes it exciting. They can select a place most congenial to them, and perhaps a roommate. Since we have such a variety of students, it's appropriate that we have such a variation of accommodations. It pays in the long run, since they make the decision and they gain confidence because they have done it themselves. And they learn from bad decisions.


*Carola Eisenberg, M.D.: "We help them to learn to think — and how to assume responsibility for their decisions. Life will be full of situations which present inner stress. They will have the ability to cope with these problems because they know how to reason." (Photo: Margo Woodruff)*

"We treat them like adults, and they respond that way. If we tell them what to do, they'll stay children. We gave up the role of parents a long time ago, unless there is some internal difficulty. They usually end up in a place where they're very happy, and seldom want to change."

She was impressed with students who help with orientation week. "Whenever we needed something — hands and feet and brains and eyes — they were here."

On academics: "They are under a good deal of pressure — they have to work hard to stay at M.I.T. They are competitive, but I haven't sensed a destructive type of competition; it's healthy competition. They do experience stress if they are not doing well academically — or if other stresses are preventing them from working well. Students now (and this is not unique to M.I.T.) are more seriously involved in developing professional goals and dreams — they have a more serious commitment to learning."

On the role of the Dean's Office: "Students have a lot of contact with the Dean's Office. If they want to initiate an activity, we will help with the program. If they are under stress they can come here and we can counsel them or refer them to the medical department. The Dean's Office' goals are evolving as the needs of students evolve."

M.I.T.'s atmosphere: "They live in a unique educational atmosphere, with an extraordinary faculty. What they get (and they like it) is an education that helps them with problem-solving, not memorizing facts. So they gain confidence in solving *new* problems. We help them to learn to think — and how to assume responsibility for their decisions. Life will be full of situations which present inner stress. They will have the ability to cope with these problems because they know how to reason."

About women: "There are still problems for women students, but they are decreasing. Yet we haven't arrived — the numbers of women are too small for a woman to feel like any other student. As the numbers grow, the uniqueness of women will decrease. There has been enormous progress. But we're dealing with a problem of society, not just M.I.T. It will continue to disappear, it is just a question of time. The attitude that teachers are as interested in little girls as in little boys has to permeate elementary and high schools."

On concerns: "One thing that makes this place is the wealth of extracurricular activities. My concern is that because of budget restrictions, the environment — such as athletic facilities — may be restricted."

On what must be encouraged: "In addition to professional development, we must encourage personal development. If we aren't constantly aware that personal growth is important, we'll end up with individuals who are efficient and successful, but will not reach their full potential. I hope that our students will be broad scholars, not just immersed in technical fields." — *M.L.*

**1,070 Expected in the Class of 1982; More Women and Minorities Than Ever**

As this issue went to press, the Class of 1982 was expected to settle in at 1,070 — just 20 more than the target given to Peter H. Richardson, '48, Director of Admissions, by the Faculty Council last spring. It was expected to include more women (22 per cent) and minority students (9 per cent) than ever before.

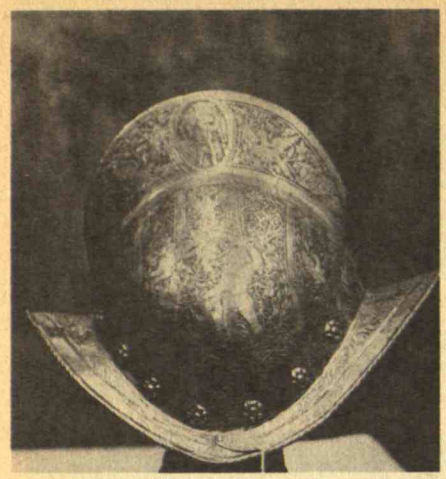
Overcrowding in the dormitories is assured by this full class and by the demand for on-campus housing from sophomores, juniors, and seniors. Lisa Kunstader, Administrative Assistant to the Dean for Student Affairs, expects that perhaps 140 rooms in the Institute houses will be accommodating more students than they were designed to serve. Jordana Hollander, '81, of *The Tech* was predicting "one of the worst overcrowding situations in recent years."

Mr. Richardson was forecasting that the Class of 1982 would include about 235 women and 95 minority students; both figures would be new records for M.I.T. He attributes M.I.T.'s success in recruiting both groups to the cumulative effect of many programs in place since the 1960s.

*The Tech* asked John Mack, '73, Associate Director of Admissions, about these programs and their possible effect in encouraging unqualified students to apply and enter. Mr. Mack responded firmly: "There is no equivocation," he said. "There is no place at M.I.T. for a poor student to hide."

The new class includes 36 students from foreign countries other than Canada. Half of all the class come from New England and the Middle Atlantic states, 11 per cent are from the South Atlantic states, 15 per cent from the North Central states, 7 per cent from the South Central region, and 11 per cent from the West. Just under 80 per cent attended U.S. public high schools and 15 per cent independent or church-related schools.

The oldest freshman is 23, the youngest just short of 16. Over 80 per cent of the entering class ranked in the top 10 per cent of their high school classes.



*Primitive chemistry in the service of decorative art. This 16th century German helmet demonstrates etching by acid — a process first described not by chemists but by armorers, says Jon B. Eklund, Curator of Chemistry in the Smithsonian's National Museum of History and Technology. This piece and many others to demonstrate the historic interface between art and technology will be in the Margaret Hutchinson Compton Gallery from October 10 through December 22. (Photo: Smithsonian Institution; helmet lent by the John Woodman Higgins Armory, Worcester, Mass.)*

**"Visitors will first enjoy the objects for their beauty, and then should think of how they came about."**

## An M.I.T. Exhibit Advances the Idea That Art Paves the Way for Science

In modern thinking about science, it is almost axiomatic that "pure" science produces information and technology turns that information to man's use. But it wasn't that way in the beginning — and it may not be that way even now, says Cyril S. Smith, '29, Institute Professor Emeritus who holds appointments in materials science and engineering and in humanities at M.I.T.

In a lifetime of studying the historical interface between art and technology, Dr. Smith has found countless examples of artisans discovering and using metallurgical phenomena which were not at all understood. "Time and time again," he writes, "very subtle properties of matter have been discovered and exploited by artists and artisans long before rigorous science even took notice of them, much less explained them."

To make this point clear is the purpose of an exhibition opening this month in the Margaret Hutchinson Compton Gallery of the M.I.T. Alumni Center: a presentation arranged jointly by Professor Smith and Jon B. Eklund, Curator of Chemistry in the Smithsonian's National Museum of History and Technology, and brought to M.I.T. from the Smithsonian where it opened for the annual meeting of the American Association for the Advancement of Science last February.

The exhibit brings to Cambridge some 55 examples of art objects in metal and ceramics, selected especially with two goals in mind:

☐ Though they range from workaday objects to those with stunning aesthetic qualities, all provide a thoroughly pleasing visual experience.

☐ All were selected to expose the arrangers' sense of the role which art — mainly decorative art — has played in the discovery of material processes.

As you survey the exhibit, writes Professor Smith in the catalog, "imagine that you yourself are the artisan. Try to get some sense of the way in which the physical and chemical properties of the various materials have operated to provide attractive pattern and texture. . . . Then think of how the artist/ artisan's observations of the constancy and variation of these properties led to the desire for the deeper understanding which is science. Think, too, of how the almost-universal human desire for pretty things has served to encourage the development of intricate methods of mass production and systems of industrial organization and commercial distribution."

Dr. Eklund added a concrete example in a recent issue of *Chemical and Engineering News.* He is convinced, he writes, that "almost the entire development of chemistry during the 18th century is reflected in the increasingly important role played by acids"; and it is no accident that "some of the earliest mentions of the mineral acids are in conjunction with etching." A 15th century armorer gives a recipe for nitric acid used to etch metal; in the 16th century a sculptor describes how hydrochloric acid can be used to etch marble. The "rather crude acid preparations" enumerated by such artisans "remained in the literature well into the 18th century," Dr. Eklund writes.

So the exhibit follows the experience of humanity, writes Professor Smith. Visitors will first enjoy the objects for their beauty, and then should think of how they came about. In the same way, people since the beginning of recorded history have been "first discovering and enjoying various aspects of their world and then using the intellect analytically in the search for structure and process." — *J.M.*

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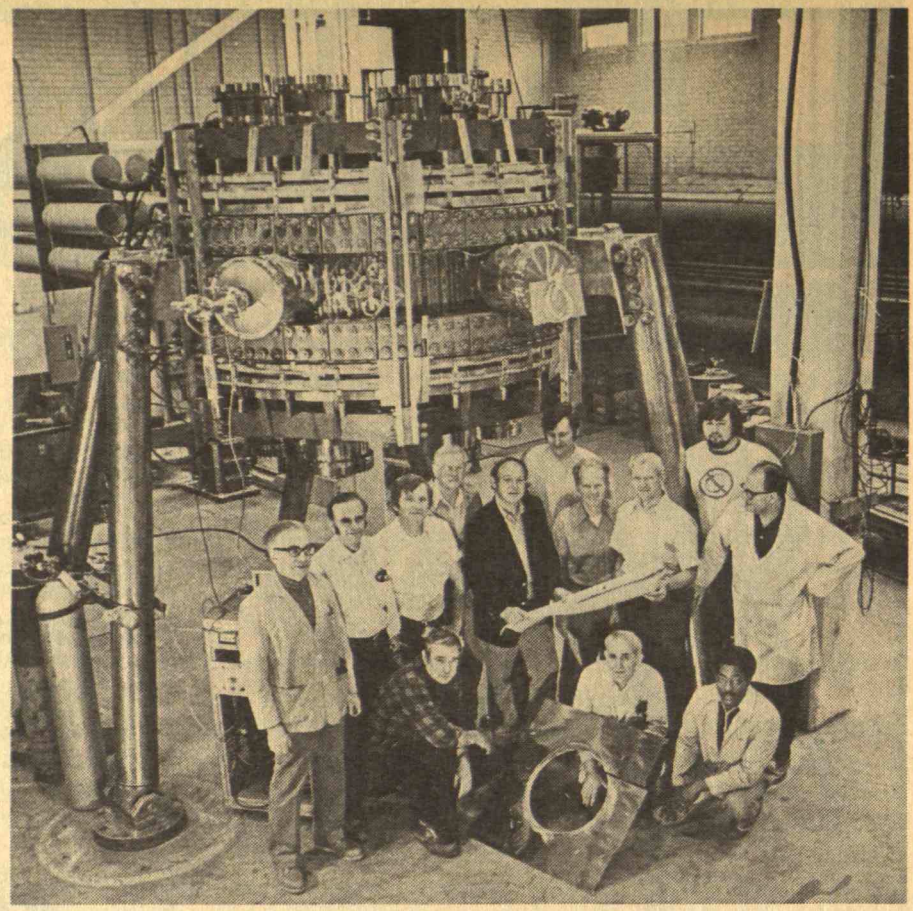
# Under the Domes



*Some $6.7 million will have been spent by these scientists and engineers in the Francis Bitter National Magnet Laboratory before they finish the machine in the background — Alcator C. It's an important step toward fusion, which Edwin E. Kintner, S.M. '46, says is "the sole large-scale energy resource which can be considered as the basic energy for all men for all time." To the members of the Alcator project at a dedication ceremony for Alcator C on April 7, Dr. Kintner offered congratulations: "In my judgment, the M.I.T. program has been one of the most cost-effective in world fusion research," he said. (Photo: Calvin Campbell)*

### A New Alcator: Toward "the Basic Energy for All Men for All Time"

Proponents of fusion as the energy source of the future had their day at M.I.T. on April 7 when its Washington-based sponsors came to the Institute to dedicate a new experimental plasma fusion machine, Alcator C.

Alcator C has not yet produced power — or even been fully assembled. But Edwin E. Kintner, S.M. '46, Acting Director of the Office of Fusion Energy in the Department of Energy, is confident. The accomplishments of its predecessor, Alcator A, were "dramatic . . . one of the best reasons for believing that fusion can be developed to a point of economic usefulness," he said.

"We are attempting to do something in fusion that has never been done before in history," Dr. Kintner said ". . . to generate support for a nonmilitary program at a high budgetary level for a long period of time with no guarantee of the result.

"We have no near-term commercial profits to offer," Dr. Kintner declared. "We can only offer the vision that when we have learned enough about the fourth state of matter to turn it to practical use, the benefits which will then accrue will justify the long, difficult, and expensive road we have had to walk to get there."

That is the principal point of Alcator C — to convince policymakers that fusion is more than a wishful gleam in the engineers' eyes. Dr. Kintner and others at the ceremony made clear their confidence that this mission will be accomplished when Alcator C adds new insights and confidence on the control of high-energy plasmas.

Work on Alcator C, a "magnetic-bottle" device to contain hot plasma as it reaches the temperature at which hydrogen nuclei fuse together to form helium, is proceeding apace. The basic assembly is complete, and preliminary testing is underway, says D. Bruce Montgomery, '56, Associate Director of the Francis Bitter National Magnet Laboratory who has overall design and engineering responsibility for Alcator.

Alcator C is the second version of an

Alcator — magnetic "bottle" — machine at M.I.T. Alcator A, in operation at the Magnet Laboratory since 1972, holds a very important world record in fusion experiments — the longest confinement time of the hottest gas, $3 \times 10^{13}$ seconds per cubic centimeter at a temperature of 10 million degrees Celsius. Alcator C is supposed to yield by 1980 a density-confinement time of $10^{14}$ seconds per cubic centimeter at a temperature of about 20 million degrees. If later machines can extend that temperature to 60 million degrees, the elusive "breakeven" criterion will have been met.

**New "College" of Science, Technology and Society**

A total of $2.5 million is now available to support the work of the new College of Science, Technology and Society. (See *December, pp. A1-A2*) Its focus, described by President Jerome Wiesner, is "on the humanistic aspects of technological society — its culture, the lives of its people, their attitudes, perceptions, problems, goals and prospects." He feels that "the findings of science and the applications of engineering are now so directly engaged in the workings of society that professional education for scientists and engineers must include the study of ways in which scientific, technological, social and human elements interact to give shape to society."

Director of the new program is Professor Donald L. M. Blackmer, Associate Dean of the School of Humanities and Social Science.

The funds come from three foundations: $1 million each from the Alfred P. Sloan Foundation of New York and the Andrew W. Mellon Foundation of New York, and $500,000 from the William and Flora Hewlett Foundation of Palo Alto, California, and development of this new unit within M.I.T. is now proceeding. Faculty members will be drawn from various disciplines and departments; there will be undergraduate and graduate teaching; and the program is intended to act as an Institute-wide, integrative forum for interested faculty and students from different disciplines. Other participants — faculty members from outside M.I.T. and interested persons from business and government as well — will be welcome.

At the core of the appointed faculty are Professor Kenneth Keniston, who is Andrew W. Mellon Professor of Human Development; Professor Leo Marx from Amherst College, who is the William R. Kenan, Jr. Professor of American Cultural History; and Professor Gerald Holton of Harvard University, who is at M.I.T. on a part-time basis as Class of 1949 Visiting Professor in physics and the history of science. Professor Elting Morison and Robert Morison are also involved. Next year the group will be joined on a half-time basis by Professor Leon Trilling of the Department of Aeronautics and Astronautics.

**". . . to Enhance the Quality of the Mind and the Spirit"**

*The following are extracts from the review by Robert Taylor in the* Boston Globe *of "Gyorgy Kepes, the M.I.T. Years, 1945-1977," the spring exhibition in the Hayden Gallery:*

For more than 50 years Gyorgy Kepes has been engaged in confounding science and making art more rational. To put it less picturesquely, he has spent his career examining the interplay of the scientific and the artistic and demonstrating that our ideas about them are apt to be rigid and absolute.

What sets Kepes apart from others interested in the art-science partnership is his understanding that vision and insight are not the same thing. He is no scientific determinist. Kepes has committed himself to expanding the language of vision; but the sort of experience that attracts him usually addresses the issue of how technology and art can effectively collaborate to enhance the quality of the mind and the spirit.

"In painting," he says in a statement about his current M.I.T. exhibition, "I am not satisfied with the muscular acrobatics of violent lines and explosive colors with their compassless abandon. I am searching for low-energy experiences which, in their subdued scale, allow more embracing patterns of order."

He goes on to state that his painting allows him to discover a "new meaning for landscape." Nearly all his paintings are personal, and, if I read them aright, constitute an anti-thesis to the abstract expressionism that dominated the U.S. art scene soon after Kepes came to M.I.T., where he was to shape the visual arts program from 1945. The abstract expressionists thought of art in heroic terms; their "crisis" aesthetic, the notion the crisis in European culture had given them the responsibility for carrying on that culture, implied an attitude of individual aspiration, a Renaissance ego. But Kepes' "low-energy" experiences constitute another aspect of art, the quietist, mystical egoless intensity of a Ryder, a Morris Graves, a Mark Tobey.

These "low-energy" experiences involve individual acts of perception. The inspiration might be the threads of light perceived by an observer flying over a night landscape, the undulating patterns left by tides on a beach, the cracked configurations of puddles and stones in a city gutter. Kepes' first paintings here particularize such experiences. With their soft, earthy color and vertical, screen-like formats, they suggest the influence of Oriental calligraphy and asymetrical images. The artist is still close to actual representation.

The paintings of the '60s and '70s reiterate Kepes' involvement with light. Sometimes it is a source within the picture, sometimes it spreads from behind the picture plane as it does in a Rouault. Occasionally it is diffused, bent and refracted, like the dusky light in cathedrals.

Kepes belongs among the transcendentalists of the visual arts; unexpectedly so. His painting "Rainbow" (1974) employs a visual motif that would have been sympathetic to a Thomas Cole or a Frederic Church, but, characteristically, the rainbow's arch consists of granular monotone and the colors of the rainbow burn in a separate section of the composition. The most recent painting, "Pythagoras' Garden" (1977) with its luminescent reds and geometric figurations, is aptly titled. Like his great classic precursor, Kepes has been immersed in science, but has used science to transcend itself, seeking truths beyond the facts of appearance.

**No "Bakke Quotas" at M.I.T.**

The Supreme Court's decision in the case of Allan P. Bakke — that he had been unlawfully denied admission to the University of California (Davis) Medical School becase of the places reserved in that School for minority candidates — will not deter M.I.T. from its commitment to minority admissions. And since this commitment is not fulfilled by a "quota" system, the Bakke decision probably does not affect the Institute's admissions program at all.

In a joint statement late in June when the Bakke decision was announced, President Jerome B. Wiesner and Chancellor Paul E. Gray, '54, noted that "M.I.T. has no quotas nor a fixed number of places in the class 'set aside' for minority students, the particular feature of the University of California Medical School admissions procedure to which the Supreme Court took exception."

Then they continued, "M.I.T. is strongly committed to providing the opportunity for an M.I.T. education for members of racial minority groups; and, consistent with the Supreme Court decision, we will continue to make a determined effort to increase their number among the M.I.T. student body.

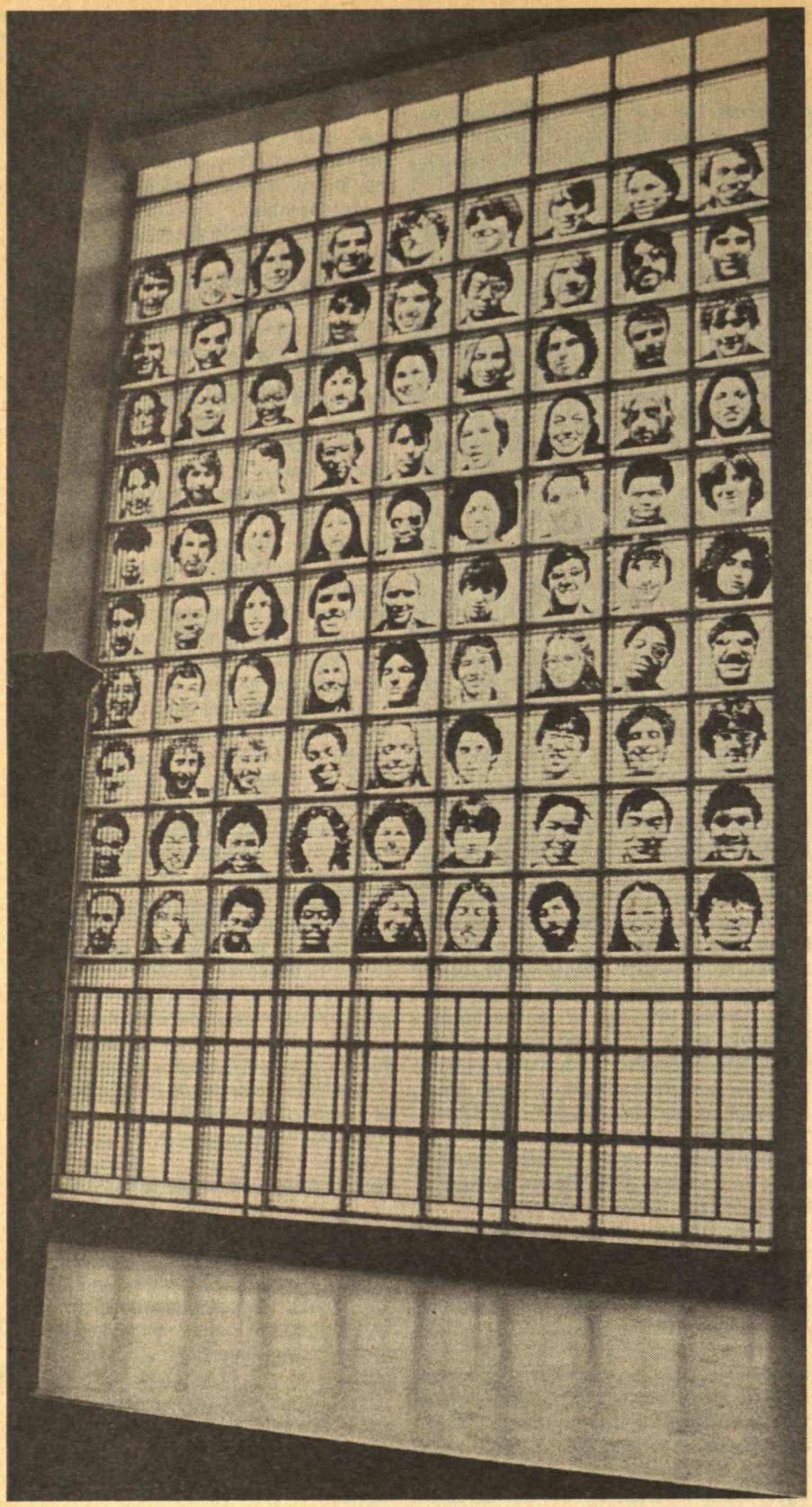
"We hope the decision will not be misread as a signal to lessen efforts to increase opportunities for minorities in our society."

**Faculty Club Memberships for Alumni**

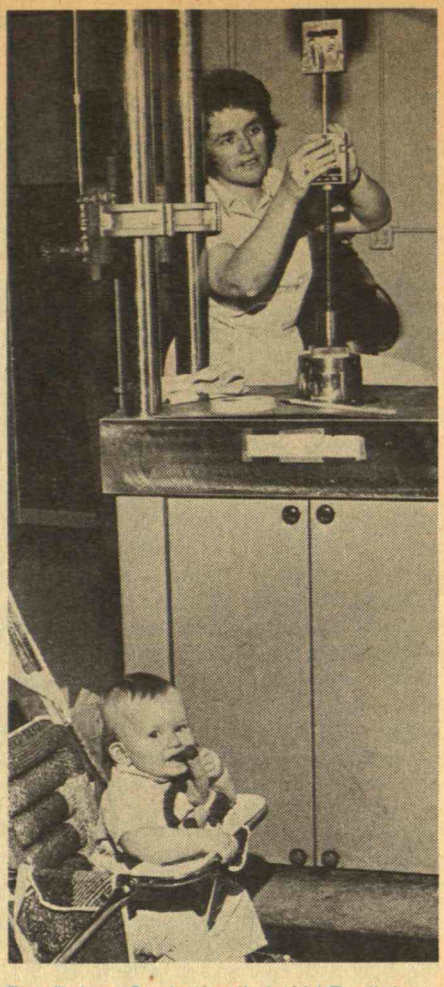
The privileges of the M.I.T. Faculty Club are now available — at a sharply reduced price — to all alumni of the Institute, and Professor Robert L. Bishop, Chairman of the Club, says that special programming designed to interest alumni members will begin in the fall.

The charge, effective immediately, is $15 a year; this payment assures use of all Club facilities — dining room, bar, and lounge as well as private dining and conference rooms.

Applications should be sent to the Manager of the Faculty Club, Sixth Floor, 50 Memorial Dr., Cambridge, Mass., 02139.



*For three days Nina M. Frankenheim, a graduate student in the Center for Advanced Visual Studies, stood on the stairs in Building 7 asking students to pose for informal portraits. They were "fantastically cooperative," she says, and now their pictures adorn the window of the stairwell. Ms. Frankenheim made her prints on a transparent material; changing light and ripples in the glass bricks which make up the window create varied images throughout the day. "I'm interested in light and the photographic image — seeing through things — and I'm also interested in how to get people involved more in public places and spaces," says Ms. Frankenheim; "so this seemed a natural combination." (Photo: Calvin Campbell)*



*The Robert Goeke family is M.I.T. all the way. Robert himself, who graduated with the Class of 1965, works in the Center for Space Research. Betsy Goeke (above) is Technical Instructor in the Mechanical Engineering Department; she's shown at work on a stress testing machine. And Beth Goeke, 10 months old, comes to M.I.T. every two weeks to be a subject in a Psychology Department study of visual acuity; that takes half an hour, so she spends the rest of the day supervising her mother's work. (Photo: Calvin Campbell)*

*How good is the steel in the* U.S.S. Monitor, *the Civil War ironclad warship which sank off Cape Hatteras in 1862? A piece of a bottom plate from the Monitor is now at M.I.T., and the answer to that question should soon be forthcoming from Robert E. Ogilvie, Sc.D. '55, Professor of Metallurgy. The sample was brought to the Institute by Gordon Watts (above, right), an archeologist with the North Carolina Department of Cultural Resources, and this picture of the transaction was made by Professor Harold E. Edgerton, Sc.D. '31, whose underwater cameras and sonars helped locate the* Monitor *four years ago.*

*More than 25 years ago, Harry H. Young, '91, gave his collection of 29 antique terrestrial and celestial globes to his alma mater. They've been in storage much of the time since then, awaiting the proper auspices and location for showing. Now that's been found, and Gerald L. Alexander, Chief of the Map Division of the New York Public Library, was called to Cambridge to supervise restoration before the collection was put on display at Historical Collections. (Photo: Calvin Campbell)*

*Drew Blakeman, '80, complained about the 1978* Technique *in a review in* The Tech: *"Occasionally art takes precedence over what should be included in a yearbook," he wrote — "the people who make the school what it is." The photograph opposite is not an example of this fault, and the editors of* MIT 79 *assume our readers will enjoy it as much as we do. (Photo: Technique 1978)*

**The Best of Possible Worlds for 1978 Engineering Graduates**

The Class of 1978 is moving into a feisty world of engineering and management challenges centered in microcircuits, solid-state devices, and energy shortage, and 1978 will go down as "the best of three good years in a row" for job-hunting M.I.T. graduates, says Robert K. Weatherall, Director of Career Planning and Placement.

Everywhere the word is the same. The Deutsch, Shea and Evans Engineer/Scientist Demand Index is at its highest point in 11 years. Raymond S. Stata, '57, President and Chairman of Analog Devices, Inc., says in his 1977 annual report that a "critical shortage of all types of engineering and management talent . . . will have a significant impact on growth rate" in his computer industry. And Mr. Weatherall says his Placement Office was "often swamped with recruiters" during the spring. "During the last weeks of April we had to hold them off."

By the middle of May it was obvious that salaries offered to M.I.T. graduates this spring in most fields of engineering, management, and the applied physical sciences would be up at least 10 per cent over 1977; and in some areas like computer science and solid-state materials the rate of increase was higher.

That's the field where the most action is, according to Mr. Weatherall — the result, he says, of "a revolution in electronics." Microcircuits and solid-state devices have reached the stage of widespread applications, and costs have been tumbling; the combination results in a scramble for people who can help countless industries capitalize on these new technologies.

Most M.I.T. students opt for small, high-technology companies. But industry is changing, says Mr. Weatherall. Basic industries such as automobiles — which have seemed unimaginative and therefore unattractive to Institute graduates in the past — are now looking for high-technology solutions to their technical problems, and they want M.I.T. students to implement them. There's also, he thinks, a new wave of innovation in aerospace born of new defense systems and the need for a new generation of commercial aircraft within 10 years.

*Cutting Short by Cutting Graduate Study*

For physical science students who do not have skills in these scientific applications — and for architecture and planning students — 1978 remains a bleak scene. Academic jobs are scarce and the competition intense.

That's one reason why the proportion of M.I.T. undergraduates continuing on to graduate school is falling — from 67 per cent in 1976 to 62 per cent in 1977 and perhaps even lower this year. The other reason, of course, is the temptation of today's active job market.

Facing these issues, students tend to rationalize by saying that they're "tired of studying" and ready to go to work after 16 years of school. But Mr. Weatherall is concerned: he thinks many may be "cutting short their ultimate achievement" by stopping too soon. The market for doctorates in engineering is active indeed; the top offer recorded by May 15 to a Ph.D. candidate in computer science was $25,980. Most students graduating with S.M. degrees from the Sloan School of Management will take jobs with starting salaries of about $24,000.

Many of this year's many recruiters have been enthusiastic about the M.I.T. students they've seen, says Mr. Weatherall. He concludes that "an M.I.T. education has never been more complete, both in developing professional skills and in producing first-rate individuals."

**Here Come the Marines**

A new option within the M.I.T. Naval R.O.T.C. program now leads to commissions in the U.S. Marine Corps.

Students who want to become Marine officers will take special courses in their junior and senior years and will spend the summer between those years in precommissioning training — the "Bulldog Cruise," which the Corps calls "a rigorous and intensive introduction to the Marines" — at Quantico, Va. Two Marine Corps instructors are now stationed at M.I.T. and already Curtis H. Fennell, '78, has completed Marine Corps requirements and last June became first Marine officer commissioned at the Institute.

# ALUMNI TRAVEL PROGRAM 1978-79

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

**AEGEAN ADVENTURE — 23 Days:** The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

**MEDITERRANEAN ODYSSEY — 22 Days:** An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

**VALLEY OF THE NILE — 17 Days:** A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

**THE ORIENT — 29 Days:** A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

**BEYOND THE JAVA SEA — 32 Days:** A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

**MOGHUL ADVENTURE — 30 Days:** The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

**SOUTH AMERICA — 28 Days:** An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

**THE SOUTH PACIFIC — 28 Days:** An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

**EAST AFRICA — 21 Days:** A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

*Prices range from $2,295 to $3,575 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:*

**ALUMNI FLIGHTS ABROAD**

White Plains Plaza, Dept. TR10, One North Broadway, White Plains, N.Y. 10601

## 03

Your secretary has overcome the rigors of a record-breaking New England winter. My brother who lived with me has been required to enter a new rest home in nearby Woburn, Mass. So now I live alone in a modern two-family home, which I hope to sell very soon, as my living alone under such conditions is a precarious one. My son John's three-acre estate with ample woods awaits me as an abode in the peaceful bluegrass country of Kentucky. Meanwhile, I enjoy the affectionate interest of my neighbors, two of whom even celebrated my birthday in April with a festive dinner at my home with a birthday cake and extras. My unusual, perfect health with normal heart has aroused my son Paul in Hayward, Calif., and cousins in San Francisco to plan a summer visit.

I just received an inspiring letter from **"Barry" Cox** at 1200 Madison Ave., Wenatchee, Wash. He is alert, takes a daily walk, and enjoys a plain, simple diet and restful day as I do. Moreover, he wants to hear from our remaining classmates — to what they attribute their longevity. He notes the average life span today is 67 years, so we classmates are ahead over 30 years. Perhaps the lack of dormitories when we were studying on Boylston St. is a prominent factor. Most students commuted to classes, and the absence of campus social facilities assured us of exercise but robbed after-class attendance in the library and intercourse at laboratories with professors. — **John J. A. Nolan**, Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

## 10

We regret to report the death of **Robert F. Burnett**. His widow, Marian, kindly sent us a note with a brief description of his career: "After graduating, Robert spent a few years with the Oliver Iron Mining Co. on the Mesabi Range in northern Minnesota. Since 1914 he he had been in the utility business as manager of gas and electric companies, first in Oswego, N.Y., then Westerly, R.I., and lastly, until his retirement, as district manager at Fall River, Mass., of the Fall River, Attleboro, and Norton Electric Companies. He was a charter member of Theta Chi Fraternity, Beta Chapter.". . . **Leroy Briggs** of Weymouth, Mass., died on July 14 at the age of 90. After leaving M.I.T., Mr. Briggs went to work for Thomas Edison as one of his personal assistants and was connected with projects that included perfecting the Edison film projector. After leaving the Edison laboratories, he was affiliated with the Gorha Manufacturing Co. of Providence. At the time of his retirement 15 years ago, Mr. Briggs was a consulting engineer. — *G. L.*

## 12

Your secretary and his wife Julie, on their way east for the summer, stopped off at Woodbury, Conn., to see **Harold Manning**. We had a very nice visit with Harold. He has been in the Hall Rest Home at Woodbury since his wife died several years ago. This is one of the most attractive rest homes we have seen. It is on a wooded hillside in the country with a small pond in front and a patio with flowers at the back door. Harold gets about slowly with the aid of a cane. We discussed old times and looked at some reunion pictures which I had with me.

We also visited **Cornelius Duyser** at Harwinton Ct. Since Cornelius' wife died in 1965, he has been living part time with his daughter at Hartford, Conn., and part time with his son at Harwinton. Born in 1885, he is one of our oldest classmates. Many of you will remember him as captain and manager of our tug-of-war team. It was sure nice to visit with him.

Julie and I also visited **Wallace Murray** in the hospital in Portland, Maine. He is doing well and in good spirits. He plans to be in a nursing home for a while and then will go to live with his son on Sebago Lake.

I had lunch with **Jim Cook**. Jim has lived in a nursing home for a number of years. He manages to get out and walk a couple of miles each day, weather permitting. Jim used to be quite a "clammer" and had his special places to collect sea clams. One year, when he visited us at camp, he brought a huge bucket of clams and a gallon of cream for clam chowder. At our recent lunch together, I noticed that Jim ordered clam chowder first thing. Another specialty of his used to be blancmange, made from sea weed which Jim personally collected.

**Harold Brackett** and his niece Eleanor Forbes spent a few days with us at Squam Lake, N.H. Fishing was poor, but we were able to keep the larder filled. Harold, as you probably know, was quite ill this past winter. He is fully recovered now but has to take it easy and is still somewhat wobbly on his feet. Julie and I spent a couple of days with Harold and Eleanor at their ancestral home near Portland and partook of some of Eleanor's fine cooking.

Fishing not being so good at camp, Julie and I took a day off to call on **Rock Comstock** at Willford, N.H. When we saw him a year ago, he was painting the house, something he had been at for some 20 years. I estimated at the time that it would take him another 20 years to complete the job. I think he is slipping on this schedule, for we could see no evidence of additional paint having been applied during this year. Rock says he has the paint and everything on hand but has just been too busy.

**Jonny Noyes**, having broken his hip last winter has been undergoing physical therapy. A letter from him states that his hip operation was not a success and all the "pig iron that was installed will have to be excavated and a complete metal ball and socket put in." After his new operation he will be staying with his son Jonathan H. at his home, 930 Coral Place, Corpus Christi, Tex. 78411.

I also received a very nice letter from George Bakeman, '13. George started with us in 1908 taking course IX but after two years had to drop out for a year to recoup finances. While technically a '13 man, he says he is rather more a '12er. Some of you will undoubtedly remember him. George lives at Hanover Court House, Va. 23069, where he has been Vice President of the Virginia Medical College for many years. He has very kindly invited me to visit him the next time I go to Richmond to see my daughter. — **Larry Cummings**, Secretary, R.R. 4, Connersville, Ind. 47331

## 13

It is with great sadness and regret that I have to inform you of the death of my dear husband and your secretary of many years. **George Philip Capen** died on July 19, 1978.

Phil had suffered two coronary spasms in the last six months. They had not paralysed him, nor affected his speech or his mind. However, he kept getting weaker and fell frequently, usually without disastrous results.

However, on July 10, as I was helping him back to bed, his legs gave out and he fell. This resulted in a broken arm for me and hospitalization for us both. He seemed to be coming along all right, but on July 19, he simply went to sleep and didn't wake up.

George, 87, was born in Evanston, Wyo., and lived in Canton, Mass., for 74 years. He graduated from Canton High, went to Pratt Institute in Brooklyn, N.Y., and later attended M.I.T. He had been a supervisor of hospital maintenance in Boston until his retirement 22 years ago. Long after his retirement, however, he remained active in civic affairs. Among his activities were chairman of the Canton Board of Selectmen in 1923, Town Clerk in 1931 and 1932, Chairman of the Republican Town and Norfolk County Committee, Court Officer of the General Court of Massachusetts and assistant to Governor Leverett Saltonstall and member of the Rotary Club and the Trinity Episcopal Church of Canton. He was a veteran of World War I as a first lieutenant.

M.I.T. had always been a large part of Phil's life. He was very proud of the Institute and the fact that he was a part of it. He also talked about and thought so much of the many friends he had made there, not only among his own classmates, but also among members of the staff.

We were surprised and very pleased to receive a phone call from "Arry" and **"Larry" Hart** from Colorado. They had learned of Phil's death through Larry's and my former association with Johns-Manville. Larry has not been too well the last few years, but he sounded like his old vigorous self on the phone.

I will try to carry on for Phil with Janet's help as I think he would want us to. Best wishes to you all. — **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

## 14

**Philip S. Platt** wrote in June that his memoirs, 280 pages, had recently been published.

*Roger Williams, '14*

**Roger Williams** died on February 23, 1978, in a hospital near his home in Buckingham, Penn., at the age of 87. After attending the University of Nebraska, he joined our class in the junior year and received his bachelor's degree with us in Course V. For two years after that, as an assistant at the Institute, he did graduate work in physical chemistry; and for the next two years he was a research chemist with the Nitrogen Products Co. in Rhode Island. In 1918 he joined the research staff of the chemical department of E. I. DuPont de Nemours & Co., and when that company entered the synthetic ammonia business in 1924, Roger Williams was made chemical director of a DuPont subsidiary organized to pioneer in that field. He soon saw the potential importance of nylon and instituted a program that enabled the ammonia department to be ready with a satisfactory process for making nylon intermediates by the time DuPont undertook commercial production of the new fiber. Early in 1943 he was named assistant general manager of the explosives department and was made head of the project for the production of the plutonium so essential to the success of the atom bomb. This was a task without precedent, and resulted in the design, construction and operation by DuPont of a plant at Hanford, Wash., of unusual size and complexity; its success was recognized by the award to Mr. Williams of the U.S. Medal of Merit. In 1945 he was elected a vice president, director and member of the executive committee of DuPont, assumed the duties of advisor on research and development, and had a major part in shaping the postwar expansion of DuPont's research. He retired as vice president and executive-committee member in 1955, but continued as a director until 1967. His achievements in the synthesis of nylon intermediates and other chemicals, and in the production of plutonium, led to his receiving the Perkin Medal of the American Section of the Society of the Chemical Industry in 1955. His distinction as an industrial scientist was acknowledged by degrees of Doctor of Science granted him by the University of West Virginia in 1938 and by the University of Delaware in 1947. He lived during his last 15 years on the farm in Buckingham owned by his son, Roger Williams, Jr., where he had considerable responsibility for such aspects of its management as the selection of farm machinery. Besides his son, Mr. Williams is survived by four grandchildren and a great-grandchild.

**Freeland H. Leslie** has a new address: 6152 N. Verde Trail, Apt. A228, Boca Raton, Fla. 33433. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

# 15

At the close of the year (June) for the annual solicitations to the Alumni Fund, Joyce Brado, our class agent had done a remarkable job. The number of donors, the percentage of the Class as donors, and the total amount given were among the highest of all the graduating classes. Nice going, Joyce, and many thanks to all you donors. Let's do as well this next year.

A few faithful classmates still contact me. **Phil Alger** is hobbling around home in Schenectady. He has had a tough time. . . . **Alton Cook** plans to divide the oncoming winter between Florida and visiting his daughter in California. He doesn't like to travel but he likes these trips to get him away from the uncomfortable winters here. . . . **John Dalton** likes his retirement in Providence, where, he says insurance and jewelry make up for the lack of science and engineering. He still enjoys contract bridge and golf and good health.

**Wayne Bradley** spends a night with me each week and we have a nostalgic visit reviewing our old school days. . . . **Dinger Doane**, retired and living in nearby Melrose, comes to see me. . . . **George Easter** continues active and lively for his age. After recovering from a fractured leg, he flew to Toronto, then to Holland and on for a tour in Switzerland and the Rhine. Wonderful for him! There are fewer and fewer of us left, so write about yourself. — **Azel Mack**, Secretary, 100 Memorial Dr., Cambridge, Mass. 02139

# 16

At our 62nd Reunion, **Don Webster** suggested that an effort be made to mark the site of Tech on Boylston Street. He'll be pleased, then, to know that this was recently done as described in this excerpt from an article in the June 9, 1978 issue of *The Wheel*, published by New England Mutual Life Insurance Company: "One proof of the reverence of Bostonians for our city's past is the many plaques and signs which can be seen around town marking sites of historical significance. This vast collection was added to on May 30 when N.E.L. Chairman of the Board Abram T. Collier and M.I.T. Chancellor and N.E.L. board member Paul E. Gray unveiled a plaque on the front of the Home Office to commemorate the site of the original home of the Massachusetts Institute of Technology. Located on this spot from 1864 to 1939 was M.I.T.'s original Rogers Building, named after M.I.T. founder William Barton Rogers, which is shown in bas relief on the plaque. Witnessing the unveiling were a number of M.I.T. alumni from the Classes of 1903 through 1919 who attended school in the old Rogers Building before M.I.T. moved to Cambridge in 1916."

**Dan Comiskey**, **Nat Warshaw** and **Paul Duff** and his wife, Frances, attended the ceremony. Paul's son, also named Paul, is an officer with New England Mutual. Dan sent us the article and in his comments noted: "I spoke with Chancellor Gray, who had much information including the fact that the first classes were held in the building on Summer St. where Kennedy's clothing store is now located."

**Will Wylde** recently notified us that his wife, Ann, passed away in February, 1977 and that he recently remarried and is now living in Anna Maria, Fla.

**Frank Holmes** writes: "After over 60 years with the same firm in the poultry business, I have decided to retire. It will be quite a transition. Expect to spend most of the summer at our other home in Fitzwilliam, N.H. Sorry to miss the reunion but was in Massachusetts General Hospital, all is O.K. again now."

**Maury Holland** recently wrote that he was involved with a change of residence and a cataract operation early in June. He enclosed with his letter a paper entitled "Industrial Research in Retrospect — A talk with Maurice Holland." Quoting from the article: "Maurice Holland is a towering figure in the history of industrial research. Now retired, he devoted over a half century to the development and advancement of the research management profession. He is perhaps best known for his key role in the founding of the Industrial Research Institute. . . . For 20 years, from 1920 to 1940, Maury Holland was Director of National Research Council's Division of Engineering and Industrial Research. During the 30 years that followed, as a consultant to industry and management he encouraged and stimulated the use of research through books, articles, and addresses. In his role as organizer he was a leader at home and abroad of many committees, conferences, and missions related to the practice of industrial research. In 1925-1927 he was Special Assistant to Secretary of Commerce, Herbert Hoover, and for two years (1938-1940) after organizing the Industrial Research Institute, he served as its first director.

"Mr. Holland has received numerous awards including the Silver Medal from Sweden's Royal Academy of Engineering Sciences. He is a Fellow of the New York Academy of Sciences and of the American Association for the Advancement of Science. A prolific writer, he is author of five books in the industrial research field. This year being the 40th anniversary of the founding of the Industrial Research Institute, Chuck Galloway, the in-coming president of I.R.I. visited with Maury Holland at his home in East Greenwich, Rhode Island, to talk with him about the past, present and future of industrial research and development and the Industrial Research Institute."

To quote just two of the many questions and answers: *Another area in which you have been very articulate is the role of research in the corporation and its interactions with the other departments. Could you comment on this?* "You can look upon the corporation as a body. In fact the word 'corporation' comes from the word 'corpus,' meaning body. Using this metaphor I see top management as the brain, the marketing function as the eyes and ears, sales as the feet, and production or manufacturing as the muscle and bone. And what about research and development? I see it as the life-blood through the entire system. It provides the basic sustenance required for the growth of the corporation and for the success of all the other functions of the corporation. And it is this idea, this image, that must be communicated not only within the corporation but to the stockholders." *Few will dispute the fact that over the years you have done more than any other individual in this country to stimulate and promote research in American industry. You have said that in your speeches you used the "scare 'em" and "success image" technique. Could you explain?* "Well, my opening in hundreds of speeches before business, bankers and trade association groups went something like this: 'You carry insurance on your factory building against fire and flood; you depreciate your obsolescent machinery; you pension off your employees but you have not insured your future business unless you have some form of research and development in which you invest 2 per cent of net worth of the business — in good times and in bad.' And then I would go on and give this quote from 'Boss' Kettering, vice president of General Motors: 'Figure out your total insurance premiums for one year, take the total amount and spend it each year on continuous development of new and improved products and processes to stay even with your toughest competitor. If you do not — your business is dead — put a lily on it, call in an undertaker, buy a black suit, you are on your way to the cemetery.'"

Had a nice visit in July with **Doug Robertson**. Talked with **Dan Comiskey** on telephone early in August and he and Grace are well Keep your letters coming and keep breathing. — **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, West Chelmsford, Mass. 01863

# 17

**George Henderson** writes that he suffered a trip to the hospital last May but is back home and able to putter around the golf course despite having only one good eye as a handicap. George says the good news is that **Frank Butterworth** still lives an active business and social life. . . . **Walter Beadle** has finished his term as president of the Kendall Residents' Association, so he and Christine are taking off in July to visit his youngest daughter in Darien, Conn. Then they will go to Cambridge for a week to take a summer course at M.I.T. and on to Southeast Harbor, Maine, for the month of August. After that, they will take a bus trip in early October to Virginia and North Carolina but will be back in time to attend the class reunion at Sturbridge.

A letter from **Luther Lauer**, from whom we have not heard in some time, relates his business and retirement activities. Luther worked for Monsanto, DuPont, and then Allied Chemical for years until his retirement in 1954. He has worked in research and development operations and long-term planning of pharmaceuticals. During World War II, he

was responsible for the development and operation of an explosives plant. Since retirement, his first wife died, but he has now remarried a widowed friend. They have travelled in Europe, Central America and Australia, which he says has given him some rewarding experiences. . . . **Stan Lane** has been having company this summer at his home on Lake Blaisdell, N.H. In July, Doris and **Bill Hunter** had lunch with him while on vacation at Newfound Lake, N.H. Then a few days later, **Stan Dunning** and his wife Jeannette spent a weekend with him. Stan has a lovely house on Lake Blaisdell and another elegant building for recreation on the lake shore. He calls it "The Barn." Stan is always glad to welcome his friends there, where he will stay until after Christmas.

We have a letter from **Ed Joslin** in Concord, Mass., who despite his 87 years is still able to enjoy gardening. Ed suffered the loss of his wife in 1976 and has had several minor accidents and illnesses, but he still enjoys life and news of his classmates. Ed's professional career started as Village Engineer in Willoughby, Ohio. Then he was with the U.S. Forestry Service and later the 23rd Engineers during World War I. After that he became Superintendent of Streets in Concord, Mass., for 40 years until his retirement.

We regret to report the deaths of two of our classmates. **Clifford Winton** died in Gouldsboro, Maine, on March 13, 1978, and **Forrest M. Hatch** in Quincy, Mass., on April 2, 1977.

The death of **Noah Gokey** was reported in the August/September issue of the *Review* with only a simple notice of his death. Since then, we have received from his son further interesting details of Noah's active and retirement activities. Noah had a distinguished career in the U.S. Navy for 33 years, serving from March, 1917, to July, 1950. During this time he commanded the Norfolk, Va., shipyard, and had duty at the Boston, Charleston, Pearl Harbor and Philadelphia shipyards. He attained the rank of captain. During World War II, he served as head of the contract branch of the Bureau of Ships. After retirement, he administered the Luckenbach Graduate School at Webb Institute of Naval Architecture. He is survived by his son, Captain Noah W. Gokey III, and three grandchildren, Lt. James Gokey of the U.S. Navy, 2nd. Lt. Patricia Gokey of the Air Force, and Daniel Gokey. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

# 18

Sadly, we have several deaths to record this time. **Craig P. Hazelet** died June 21, in Louisville, Ky. He was an internationally recognized consulting engineer and designer of the Sherman Minton and John F. Kennedy bridges, which won national recognition from the American Institute of Steel Construction. He is survived by two daughters, four grandchildren, and four great-grandchildren. . . . **Robert L. Gifford** died April 1, after an illness of several weeks, in Sandwich, N.H. He spent most of his business career as an engineer on the staff of the Blackstone Valley Gas Co., in Rhode Island. He is survived by his wife, Dorothea, two sons, two daughters, 11 grandchildren, and two great-grandchildren. . . . We must also report with sorrow the deaths of **Henry Pinkerton** in St. Louis, Mo., on April 29, and **Harold Atwell** in Bradenton, Fla., on June 8.

On a happier note, the news of our recent reunion has sparked warm memories of the past 60 years. **Harold Weber** recalls school days shared with **Al Murray**: "Al and I were radio instructors at the M.I.T. Army Ground School in 1917. With H. N. Carlson in charge, we wrote a pamphlet on radio which was the school text — I still have a copy. Al and I were close friends and we cooperated on what was our first consulting job: finding out why batteries in a small code practice unit did not last very long. We received $100 for our work. I have not seen Al since 1917 but I have often thought of him."

**Granny Smith** couldn't make it to the 60th Reunion — he was recovering from an operation at the time. The doctor did approve Granny's plans to visit his sons and their families — and, later, to

## Holland: A New Sermon, Same Lesson on Managing Research

If management is the brain of the corporation, marketing its eyes and ears, sales its feet, manufacturing its muscle, and plant its bones, what about research and development?

The very heart, says Maurice Holland, '16, "pumping the life blood through the entire system."

"Research and development provides the basic sustenance required for the growth of the corporation and for the success of all its functions," he says.

It's the same message that Mr. Holland has been spreading for 50 years as an outspoken advocate of research to assure industrial progress; he opened literally hundreds of speeches throughout the country by telling businessmen in his audiences that 2 per cent of their companies' net worth invested in research and development was just as much insurance of their companies' future as the fire and flood policies which none would think of cancelling.

Four years after graduating from M.I.T., Mr. Holland was Director of the Division of Engineering and Industrial Research at the National Research Council, where he and his boss, the late Frank B. Jewett, '03, were determined to show how technological research was a positive force for economic growth. That effort culminated in 1938 in the formation of the Industrial Research Institute, of which Mr. Holland became Director; and he is now regarded as "a towering figure in the history of industrial research."

*"Keep Our Genius at Work"*

For I.R.I.'s 40th anniversary early this year Mr. Holland came out of retirement to preach his message once more: "Much of the financial community and many stockholders do not truly understand the innovative process and the role and function of research and development," Mr. Holland said in an interview for I.R.I. members.

He emphasizes the *management*, not the *direction*, of research. He learned that lesson early, when he once asked Madame Irene Curie what characteristics she thought most important in a director of research. Her reply; "You cannot direct research. Research must direct you. If my mother had been directed by someone, I'm afraid she would have spent all her time on small and trivial problems and never would have discovered radium."

Management is a different story, though, and Mr. Holland has a "job description" for a research manager: "He must be a leader with a fervor and dedication that he transmits to his staff. . . . He must be imbued with the research spirit and the desire to break new ground. He must be a seeker of new ideas and at the same time have the business sense to select and pursue those ideas that stand the best chance of commercial success."

But the manager's job is not only to find people in his image and set them up in systems according to organization charts. Successful research needs innovators, people who can and must be left alone "to do their own thing," says Mr. Holland. The sign on that door should say, "Keep out. Genius at work."

Though Mr. Holland is now retired, the job is by no means done. "There is still a lot to learn about managing research and development . . . and about the nuts and bolts of research management and the innovative process," he told his fellow-members of I.R.I. on its 40th anniversary.

fly to his summer cottage in Wayne, Maine. He reports that two of his seven grandchildren are on foreign duty, one in Singapore and one as chief engineer on a seagoing tug.

A constant fresh breeze from the West, **John Abrams** is our faithful correspondent from Bishop, Calif., in the high Sierras. From his high vantage point, this rugged individualist issues forthright blasts at government bureaucrats who tamper with the rights of the average citizen. Our 60th Reunion sent John to his strongbox, from which he extracted his correspondence with the fondly remembered, erudite **Alexander Magoun**. Maggie served us well as Class Secretary for 50 years, and his columns seem just as fresh and newsy today as ten years ago. And, from Maggie's column, John's 50th Reunion salute to his schoolmates — quoting General McArthur's Credo — is even more appropriate for our 60th:

*Whatever your years, there is*
*in every being's heart*
*The love of wonder, the undaunted*
*challenge of events,*
*The unfailing, childlike appetite*
*for what next. . . .*
*You are as young as your faith, as*
*old as your doubt.*
*As young as your hope, as old as*
*your despair. . . .*

Ten years ago, Alexander Magoun gave us what turned out to be his final wish for the Class of 1918, and it's well worth recalling: "Let us all have an unfailing appetite for, 'What next?'" — **Max Seltzer**, Secretary, 60 Longwood Avenue, Brookline, Mass. 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington Street, Brookline, Mass. 02146

# 19

Due to the war, most members of the Class of 1919 departed from M.I.T. in the preceding year, 1918. However, true to custom, the regular five year reunions have been marked by good attendance and pleasurable meetings with classmates. And now the 60th Reunion is being organized for 1979. Watch for notices and decide to attend to show M.I.T. we're still in business.

I had an interesting telephone talk with **Paul Sheeline**. I found him busy in his office involved in activities around what turned out to be the biggest day ever in the stock market. Paul doesn't believe in "all work and no play" though. He told me of a recent trip he and his wife Jean made to California visiting friends in Palm Springs, Beverly Hills, and San Francisco. Paul hails from Frisco, as did his father; indeed his dad once lived on the spot now occupied by the world famous Mark Hopkins Hotel. While Paul would still like to play tennis, he satisfies himself now by watching others. He and Jean did just that at the recent matches in Wimbledon. While there, they stopped at the Intercontinental Hotel in London where they enjoyed the exquisite service and also the high prices.

An informer tells me **Jack Stevens** is now in Florida; he has many happy memories of the times spent with Dr. **Eugene Smoley**, our class secretary for so long. Jack hopes to attend the 60th, we do too. . . . **Paul Blye** didn't expect my telephone call. I found him at home in fine spirit and health which applies also to his good wife. Blye has been retired from Bell Labs for 16 years so he is well trained at retirement. He finds pleasure in his garden even though he walks around with a cane. He is very proud of his son who is an important person with the National Institute of Health in Bethesda, Md. His son got a good start at M.I.T. for two years, concluded his education elsewhere, and finally completed it with a Ph.D. right here in New Jersey at Rutgers.

I found **Don Way** at home in good health and anxious to be of help for our 60th. Classmate readers who have met his wife Barbara at past reunions will be interested to know that I couldn't include her in my call to Don — she was out playing golf.

I have seen a copy of a note from Mildred von Voss, the wife of **Ernest F. D. von Voss**, advising of his decease on December 17, 1976, and of her plans to make a gift in his name to M.I.T. It is with regret that I report from the Alumni records the decease of **Arthur R. Ford** of Ridley Park, Penn. So now, please send me some notes of your whereabouts, etc., or expect a call most any time. — **W. O. Langille**, Secretary, Box 144, Gladstone, N.J. 07934

# 20

A thoughtful letter from **"Toots" Kinghorn**'s son, Alan, contains the news that Toots is living at the Bayside Convalescent Hospital, 1251 S. Elisio Dr., Kentfield, Calif. Toots has resided for a number of years in Carmel, Calif. His wife, Elvira, died last year. We visited the Kinghorns several years ago when in Carmel and found them pleasantly situated there. Toots broke his hip last year and has been confined to a wheelchair since. We wish him well.

A note from **Moe Lipp** contains the good news that he and Helen are looking forward to the 60th. Moe says he still roots for the Red Sox and the Bruins but has transferred his allegiance from the Patriots to the Miami Dolphins. It is worthy of note that Moe was recently cited by the Department of Justice in Washington for his energetic and unselfish efforts on behalf of the U.S. Government in a patent suit that was successfully concluded in favor of the government. The Lipps reside at 2545 Flamingo Place, Miami Beach.

It is with deep regret that I have to inform you of the passing of two of our prominent and beloved classmates. **Jack Logan** of Bedford, Pa., died on May 13. He was with the Pennsylvania Railroad for ten years after graduation and then with Union Switch and Signal Co. in Swissvale, Pa. He retired in 1961. He leaves his wife, Anna, a son and a daughter. Word has also been received of the death of **Bob Sumwalt** of 1718 Madison Rd., Columbia, S.C. In previous issues Bob's distinguished career as educator and President of the University of South Carolina have been fully described. Both of these men have been loyal member of the Class and a lasting credit to it.

A welcome letter has just been received from Vera Howes to say that she visited Red Lion Inn this summer and recalled the good times we had at our 45th at which the late Homer was present. Vera writes that she is always glad to see anyone from the Class as it brings Homer closer. What a wonderful man and classmate he was! Vera still lives at 35 Lake Forest, St. Louis. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

# 21

Did others in the Class, thumbing through the June/July issue of *Technology Review*, come to a photograph on page B12 and say "John Barriger"? Well, it *was* John W. Barriger IV (49), son of our **John W. Barriger III**. The caption on the picture noted that he was on a hard-working committee of the M.I.T. Club of Chicago that hosted a successful conference on May 8 on "Management's Challenge in the 1980's."

I am indebted to **Don Morse** for a report on the funeral services for **Ed Dube** who died on June 30, 1978. Quoting from his letter, "Maida had decided to bury him in his red M.I.T. jacket. The family had had some misgivings about this display in the funeral parlor, so she was most pleased and relieved when four '21ers came in a group to the services with their 50-year M.I.T. jackets (she had particularly requested that). The four were **Elliott Adams, Mel Jenney, Edmund MacDonald** and myself. We walked home with Maida after the church services and visited for a short while."

A sister-in-law of **Bob Waterman**'s staying with us at Squam Lake, N.H., tells me Bob had a successful hip joint operation recently. I understand this has somewhat restricted Bob's extensive vegetable gardening both in Florida and New Jersey — much to the relief of Bob's wife, who does a large part of the canning.

My request for news from 12 randomly selected classmates last February wasn't very successful. The batting average was .083. Wouldn't some of you like to emulate our California classmates who, at **Sam Lunden**'s urging, sent in brief life histories? Or send me a tidbit. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

# 22

During the last of this golf season, we hope you are all enjoying the outdoor events in the northern states and the slightly cooler weather in the south and west.

**Robert Lay Hallock** has written a manual on how to develop, protect and sell a patentable idea at a minimum expense — and with maximum profit and satisfaction. The book makes unnecessary the question, "Why didn't I think of that?" He has invented for most of his lifetime and owns patents for 30 successful machines and accessories. He is chairman of two manufacturing companies — Gripnail Corporation and E. S. Products — which sell some of his inventions. In his philosophy for success in inventing he warns that many become discouraged and quit just short of success — so keep on trying. . . . Col. **Ray C. Burrus** is chairman of the County-Wide Metropolitan Planning Organization for Hallandale, Fla., and will continue the constructive work he has been doing in trafficway and transportation planning. Ray has been working in various organizations for many years to better the life of his neighbors and fellow citizens. . . . **Robert P. Ramsey** of Mount Vernon, Ohio, is in the energy field, actively working with gas and pipe lines for public utilities. He is also working on batteries and electric automobiles.

We will miss **Raymond E. Miskelly** of Yarmouth Port at our future meetings. His wife Jessie wrote that he had not felt well since returning from Florida and he finally passed away on August 1. Ray was director of research at the Plymouth Cordage Company for over 25 years retiring in 1965. He was a member of the Alpha Chi Sigma, a former director and vice-president of the Jordan Hospital. He was also town meeting representative in Plymouth for many years and a member of the Pilgrim Society. He was a member of Howard Masons and a Past Director Deputy Grand Master of the Grand Lodge of Massachusetts. He was always a delightful and charming addition to our Class activities and he will be genuinely missed. Our sympathy to his wife, Jessie, two sons and his daughter. . . . Our sympathy goes to the family of **John F. Austin, Jr.**, of Dallas, Tex., who passed away from a heart attack in April. He spent many of his active years in the American Smelting and Refining Company's Mexico Division and returned to the United States in 1958 to retire. He is survived by his wife, a son, and two daughters. . . . We also hear of our loss of **Albert P. Powell** of Florida in 1977. He had teaching positions at Pennsylvania State University and Lafayette College. He is survived by his wife, Margaret Newell Powell, a son Lewis of Oregon, and two daughters. . . . **Shepard Dudley** of Essex Fells and South Dennis passed away in April. He was the former president of the Aviation Division of Standard Oil of New Jersey. He was timekeeper emeritus for Essex Fells and a collector of clocks with detailed knowledge of timepieces; he kept the Bourrough Hall Clock working impeccably for four decades. Our sympathy goes to his wife Alice and his daughter, Mrs. Henry C. Gill of Needham. . . . We also send the sympathy of our Class to the families of **Manuel Shampanier**, Coral Gables, Fla.; **Hilary S. Swenson** of South Dartmouth, Mass.; **William J. Grady**, Maplewood, N.J.; **Dwight F. Johns**, Oakland, Calif.; **Herbert O. Albrecht**, Springfield, Penn.; **Harold S. Bronson**, Rochester, N.Y.; **Elmer W. Hammond**, Laguna Hills, Calif.; **John W. Ingram**, Ridgewood, N.J.; **Thomas D. Tyne**, Tinton Falls, N.J. . . .

As there are many reasons to attend the fall meetings and festivities at M.I.T., we hope that many of our Class will get together during the next

few months. When you do, please be sure to write to your secretary. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla., 33060

# 23

**Tom Drew** writes that his son-in-law, Giles R. Cokelet ('63 Sc.D.) has been appointed to a full professorship in the Faculty of Medicine at the University of Rochester. . . . **Cecil Green** has been elected by the Society of Exploration Geophysicists to be the first recipient of the newly created Maurice Ewing Medal. . . . **Joel Lund** writes that his move to Charleston has worked out perfectly and invites visitors to drop by. . . . Marge and **Tom Rounds** are on a trip of several weeks duration to California.

**R. Winston Rouse** died on June 2, 1978. He studied electrical engineering with our class and was a member of the Engineer Unit Association. He was Senior Engineer for the New York Telephone Co. before retiring to Traveres, Fla.

We have only recently learned of the deaths of **F. Robert Robinson**, on November 25, 1974, and **Frederick A. Kinch**, sometime in 1975. Robert Robinson prepared for the Institute at Norwich University in engineering and military sciences. He served in World War I, enlisting in the regular army artillery in 1917, later being transferred to the Medical Corps in France. At the Institute he studied business and engineering administration. His career was in safety engineering and insurance marketing, underwriting, and administration. In addition to his own business activities, he was chairman of the Casualty Managers' Assoc. of Los Angeles, a member of the advisory committee of the National Bureau of Casualty Underwriters, San Francisco, and was associated with the insurance commissioner's department in the state of California. He was engaged in organizing and supervising the insurance of the Vermont Yankee Power Corp. construction and operation at Vernon, Vt.

Frederick Kinch received his bachelor's degree in mechanical engineering with our class. His career was as manager of Frigidaire and household appliances for General Motors Corp., South African, Ltd., until his retirement in 1966 to Summit, N.J.

No input — no output. Please send material for class notes to your new Class Secretary-Treasurer — **Richard H. Frazier**, 7 Summit Ave., Winchester, Mass. 01890, Telephone (617) 729-3114

# 24

Barbs and **Frank Shaw**, Rene and **Ed Moll**, **Herb Stewart** and **Russ Ambach** inspected the facilities at the Exeter, N.H., Inn and reserved Friday, June 8, after noon, until Sunday noon, June 10, 1979, for our 55th Reunion. Room rates per day will range from $14 for singles to $30 for two persons, plus a 6-per-cent tax. There are 50 attractive rooms decorated in Georgian tradition with all present-day comforts except an elevator (only three floors). We plan a clambake Friday night and a banquet Saturday night. For those who may be interested in an extended Bean-Town visit, we will soon suggest a pre-Exeter schedule.

The American Association for the Advancement of Science in February elected a number of its members to be Fellows; in all, 13 per cent of those honored were M.I.T. alumni, among them our own **Harold L. Hazen**. He is internationally known for his original research on differential analyzers, leading in World War II to his being Chief of the Fire Control Division of the National Defense Research Committee. Harold retired as Dean of the M.I.T. Graduate School some years ago and now is — like the rest of us — trying to help citizens cope with the complexities of a technological society. "Hazen" and his good wife, Katherine, celebrated their 50th wedding anniversary in September.

**Don Moore** writes, "No news from an old dude my age, except to salute those old friends who have achieved the ultimate peace."

We have a letter from John M. Thompson, '34, informing us of the death of **Randolph Frantz** in Roanoke, Va., on June 4, 1978. Mr. Frantz was associated with Mr. Thompson as a partner in the practice of architecture and had established himself as one of the leading architects of that region, producing many fine buildings including the Roanoke Public Library, designated for its major prize by the American Institute of Architects.

**James F. Crist** writes, "After 40 years in electric utility industry — Vice President of the South Carolina Power Co., President of Gulf Power Co., President of Southern Electric Generating Co., and Executive Vice President of the Southern Co., I am writing a light historical narrative, *The Electric Company*, including the history of the Southern Co.

On August 5, 1978, Barbara and **Frank Shaw** celebrated their 50th wedding anniversary with an afternoon reception in their home in Wellesley, Mass. The many guests were reminded of early moves to five states in eight years, and there were individual three-foot-square "blow-ups" of sylphid Barbara and svelte mustachioed Frank near Detroit. He was presented a letter of deep appreciation from the Board of Selectmen, recognizing his many civic accomplishments over the years and his current faithful performance for five years as Treasurer of the Council on Aging. A toast concluded, "For 50 years they had a goal. Ups and downs took their toll. However, the towline never parted, they reached the peak for which they started!" — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

# 25

A note from **Lothrop Bailey** tells us that he is enjoying his 12th year of retirement in Pittsburg after 35 years at Gulf Research. He makes occasional visits to his son's art studies show room at 360 Columbus Ave. in New York City and to his wife's family in Fort Lauderdale.

**Milt Salzman**, who was a fraternity brother of **F. Del (Coo) Hastings, Jr.**, writes regarding Coo's passing which was reported in the last issue of class notes. Most of Coo's active career was spent in the hydraulic pump business as a representative for Peerless Pumps with the Turbine Equipment Division of Food Machinery Corp.

Parke A Hodges, '27, writes from Atlanta, Ga. Parke started out with our class and was well known to the Course III and XII classmates. He left the Institute to complete his bachelor's work at Harvard and returned to M.I.T. for his master's degree, hence his class designation as 1927. He feels closely attached to '25. Parke was with the mining consulting firm of Behre, Dolbear and Co. of New York City for many years, retiring about three years ago. He hopes to establish his own consulting firm in the near future. To avoid the hot summer weather he spent the last several months in San Francisco and on the eastern shores of Maryland.

A telephone call from Robert F. Miller, '21, provides some insight into the activities of **Abe Silverberg** whom he had met in Mexico. Abe is well known in the chemical engineering circles of Mexico and operates a fine metals company.

Word of the passing of two classmates reaches me through the Alumni Office. **Andrew G. Aylies** died in Cleveland, Ohio on December 23, 1975; and **George F. O'Brien** passed away on June 3, 1978. No further details are available. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass. 02650

# 26

What more appropriate location for writing class notes in mid-August than atop the new sea wall? Well, almost — there is a small lower terrace where we sit with mugs of coffee and admire the achievement. It is a 44-ft. reinforced concrete wall pinned to ledge, three ft. wide at the base and two ft. at the top, capped with granite. To improve upon the stark concrete bareness and to entertain our sailing friends, we have painted a 13-ft. burgee of our yacht club on the face of the wall. The wall was backfilled and a new lawn (with sod) established. If you would like a photo of this monstrosity just drop us a note. Our only visitor has been a member of '27 who was staying at a local hotel — Robert Engel from Southbury Conn.

The issue of the notes (May, 1978) containing a picture of the devastated wall stirred a lot of interest. A Cornell man obtained a copy from an M.I.T. friend, showed it to the owner of a local hotel, and as a result Ruth and I were his honored guests for dinner. **Jim Killian**, after reading the notes, wrote: "Your graphic description in the '26 Class Notes, plus the photograph I have just received, remind me of Wordsworth's verse:

*Where rocks were rudely heaped and rent*
*As by a spirit turbulent*
*Where sights were rough . . . sounds were wild*
*And everything unreconciled.*

I am glad to hear that shortly your front yard will once again be 'reconciled.' "

A few notes on Alumni Fund envelopes make it possible for us to leave at noon for a mid-week race and still give you news. **Bill Farr** says he married Virginia B. Wolcott in 1968 and moved to Chapel Hill, N.C. In August, 1970, they bought a home in Southern Pines. They are active in civic affairs (Kiwanis, Elks, Southern Pines C.C., Pinehurst C.C., Mens Garden Club, N.C. Art Society, etc.), play golf, and travel. Taking at least one cruise each year, they have been around South America, to Africa twice, Europe several times, and all over the Caribbean.

**Allen Cobb**'s message gives a pretty good accounting. He is now retired but does a little consulting. He's been active on the N.Y. State Building Codes Council and keeps moderately busy restoring antique clocks. He has some contacts with the Smithsonian, Constitution Museum, South Street Seaport, etc., on marine history.

And, believe it, **Art Brockelman** has come out of the woodwork with a terse but informative message: I was appointed as Class Correspondent and Secretary of my class at Phillips-Exeter Academy." . . . **Karl French** tells us he finally decided to retire in July, 1976, after missing the 50th Reunion because of illness; he still wears the blazer. Now the Senior Warden of Vestry at St. Andrews By-the-Lake Episcopal Church, he is busier than when working for a living.

These classmates have saved the day by becoming assistant class secretaries for this issue and allowing your permanent (how did that ever come about?) secretary his freedom to sail. After a week of rain, fog and no wind, it is beautifully sunny today with about a 12- to 15-knot breeze — just what we like. So with a cheerio until November issue we are off the sea. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

# 27

**Louis F. Pike** died on March 30 in New Haven. From graduation in 1927 until 1961 he was with the Connecticut Highway Department, and during this period he earned a master's degree from Trinity College, Hartford, and did further graduate work at Wesleyan University. He joined the faculty of Milford High School in the fall of 1961, where he taught mathematics until retiring in 1974. While in the school, he served as director of plays and organized a high school chess team. He was active in drama productions of the Woodbridge Club and a member of the New Haven Civic Symphony. He is survived by his wife, Mary, and by two daughters

**George Jenkins**, who completed his college work at Bowdoin after one year with our class at the Institute, writes that he was one of 40 men returning for the Bowdoin 50th Reunion this year. . . . **Doc Edgerton** has been cited for finding the sunken remains of the hospital ship S.S. Britannic, lost in the Aegean Sea during World War I. The discovery was made while Doc was hunting for

*Charlie Worthen, '28, is honored at his home for his many years of service to M.I.T. as Class Agent. Left to right: Dick Knight, Secretary of the M.I.T. Alumni Association; Walter Smith, Class Secretary; Charlie Worthen and Jim Donovan.*

treasure with Captain Jacques Cousteau. The *Britannic*, a sister ship of the *Titanic*, was at the time of her sinking the largest ship in the world.

Marion and I missed Alumni Day this year, as I was still convalescing from surgery (from which I have now fully recovered), but **Art Connell** tells me that the Class of 1927 filled two tables at the annual luncheon — not bad for an off year.

When my daughter and her family went back to Atlanta in July, they left the 6 1/2-year-old middle child, Chris, with us for a couple of weeks. There's nothing to keep you young like entertaining a small child. Marion and I actually enjoyed feeding ducks, touring the zoo, visiting firehouses, even re-reading children's stories. — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

# 28

Many letters have come from among those who attended our great 50th reunion. All have commented on how wonderful a week we had together on campus. Such events don't just happen, of course, and we take this opportunity to recognize the many contributions of those who did so much to make the party such a grand occasion.

As Class Gift chairman, **Jim Donovan** did an outstanding job — the final figure, $1,225,000, and the astonishing flood of contributions and pledges of the final few days are ample testimony to this. Closely associated with Jim in his fund work were our class agents **Tom Larson** and **Charlie Worthen**.

The Reunion Committee worked as a group to form and develop plans but special thanks are due to those who undertook the various individual task assignments. **Dick Rubin**, as class treasurer, had the responsibility of all financial matters. **Herm Swartz** was editor of the 50 Year Class Book and planned the questionnaire, bookcover and arrangement of the contents (Mary Kyger in the Alumni Office did all of the typing and assembly work for the book). Gladys and **Dave Olken** planned and implemented the project that resulted in the beautiful stoles for classmate spouses — because he is in the textile dyeing business, Dave was able to dye the mohair yarn to exactly match the cardinal red of the classmates' jackets. Gladys supervised all of the production handwork. **Carney Goldberg** designed the attractive program folders and the beautiful cardinal and gray stationery used in reunion correspondence. Dorothy Goldberg located the Corinthian Yacht Club for our clambake site. Carney and Dorothy together selected fabrics for our reunion jackets and slacks. Ruth and **Abe Woolf** planned the Boston Waterfront activity and Abe was our liaison with the M.I.T. food service. **Gus Solomons** located the Scollay Square Stompers who made our dinner dance so enjoyable. Helen and **Bob Harris** made the social arrangements for our faculty guests dinner. Edythe Rubin was in charge of the welcoming snack bar for the opening day of reunion and was ably assisted by Mary Nichols, Olivia Solomons, Dorothy Goldberg and Ruth Woolf. Florence Smith and your secretary worked on registration details and on much of the related correspondence. And all members of the committee, including Anna and **Will Tibbetts**, Janet and **Fred Lewis**, and Verna and **Rudy Slayter**, served as a hospitality group and helped to make each arrival welcome and at ease. Lillian and **Tom Larson** were particularly effective greeters.

And we certainly must acknowledge the tremendous help and cooperation given us by the M.I.T. Alumni Office personnel, especially Joe Martori, Nancy Russell and their office group — Mary Kyger, Becky Hoag, and Wendy Wolfe — who made all the arrangements for housing, on-campus registration, meals, meetings, special events, the Pops, Museum of Fine Arts, lunch at Stella Restaurant and all of the required busing. To each and all of those concerned, we express our thanks and appreciation.

Velma and **Charlie Worthen** were unable to be with us at reunion. But on Monday, July 31, a delegation consisting of Dick Knight, Secretary of the M.I.T. Alumni Association, Frannie and **Jim Donovan**, and Florence and **Walter Smith** visited Charlie at his home in Little Compton, R.I., to present him with an award of commendation from the Alumni Association in recognition of his many years of service as 1928 Class Agent. A beautiful plaque was prepared for the occasion, and Dick made the official presentation to Charlie. Charlie's wife Velma made the day festive with delicious refreshments, assisted by daughter Constance and granddaughter Grace who were visiting from California. . . . Frannie Donovan had to miss most of the M.I.T. Reunion because she was cochairing her own 50th at Radcliffe. We congratulate Frannie on her election as president of her class. We know that she will have an interesting and successful five years in that office.

With profound regret we must report the deaths of eight classmates. **Gerald S. Brickett** died on May 7, following a stroke some two months earlier. In her letter to us, his wife Miriam said that Gerry had been very active right up to the day he became ill. Gerry retired as plant superintendent from Congoleum-Nairn, Inc., in 1970. He and Miriam had planned to be with us at the 50th. . . . **Wilbur F. Broun** died on May 31. Wilbur received his S.M. degree in mechanical engineering and had been retired for many years. . . . **Wilbur L. Gaines** died on November 23, 1977. The information was sent by his wife. . . . **Theodore P. Hall** died on March 17 of this year. He received his S.M. degree in aeronautical engineering and was widely known for his technical accomplishments. He leaves his wife Marion and three daughters. . . . **Louis J. Kelly** died September 12, 1975. The information came to us recently from a member of his family. . . . **Richard B. Rubin** died on August 12, 1978. The sad news was given to us by his son just as these notes were being submitted for publication. Dick, our class treasurer, was a member of the 50th Reunion committee as was his wife Edythe. Both attended that full week. We hope to have some additional information for the next issue of '28 Notes. . . . **George Sabol** died on September 12, 1977. We have no other information at this time. . . . **Redmond E. Walsh** died on September 29, 1977. Redmond was in Course VI. . . . To each of the families we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix Street, Winchester, Mass. 01890

# 29

Like the majority of our classmates at this point in life, **Milton Male** and his wife Maxine have given up their residence of many years and moved from Pittsburgh to a more gentle climate, that of Florida. "Our apartment faces one of the five golf courses here," Milton writes, "and when the mood is just right Mac and I play golf. We are enjoying the results of the change we have made — no snow to shovel and no biting wind and freezing weather to face — we can just walk around in shorts! Our only regret is that we did not do it sooner." Milton and Maxine attended our 40th Reunion and most likely will join us for the Big One next year. . . . **Ira H. Abbott** writes, "Thanks for the birthday greetings. Nothing new, except that I am a year older, but thankful that I have my health." . . . **Bill Bowie**, our class agent has sent a note which reads in part, "I presume you and Helen are at Hampton Beach enjoying this fine summer weather. We are mostly at home in the mountains (Olmstedville, N.Y.) except for our excursions out to symphony concerts and ballets. As you know, this is the season of our maximum cultural exposure. Between the Boston Symphony Orchestra and the N.Y.C. Ballet at Saratoga, we have some 14 events scheduled in less than two months. We would like to spread it out more, but since we can't, we immerse ourselves in it all with great enjoyment. We expect to attend the M.I.T. Officers Conference in October and are looking forward to seeing you and Helen."

A note from **Wally Gale** reads, "Thank you for your annual birthday greetings which seem to come as regular as the telephone bill, but much more welcome. I do like your plug for our 50th Reunion in the class news, and hope that we can make it the biggest event ever. As for news on the domestic front, Joan and I spent the month of June with our 'children' — who are now in their mid-forties — in England and Switzerland. Tom flew up from his teaching job in Nairobi and Joanie timed her 'retirement' from M.I.T. so as to be with us. Otherwise we have been nowhere this past year, except for making our weekly visits to Boston during the symphony season (September to April). Joan's heart problem has put an end to our more venturesome trips, but with the declining pleasure of air-travel and the disappearance of gracious ships, we are happy with our lot. We are now looking forward to our 50th — and hope that all who read these class notes will join us."

I regret to announce the death of **Harcourt Vernon** on July 3, 1978. He was associated with Dupont as a chemical engineer since 1930, except during World War II. He retired from DuPont in 1972 as Associate Director of Engineering Technology and Materials Research, a post he had held since 1963. He was the original chairman of the board of the Mt. Cuba Observatory from its inception in 1957 until 1972, when he became its manager. He was a member of the University of Delaware Research Foundation, the American Institute of Chemical Engineers, the American Ordnance Association, Alpha Chi Sigma fraternity and the Delaware Astronomical Society. He is survived by his wife, Frances Hitch Vernon, and a daughter and son.

**J. Henry L. Giles** writes, "I have been out of touch with M.I.T. for the past 20 years or so, but

recently I sent in my resume through 1974. I retired from the City of Pasadena, Calif., Public Works Department as an engineer of operations in 1974. I also retired from Ralph M. Parsons Co. Engineers in 1976. At present, I operate a guest home for the elderly and at 71, (thank God) I am able to do most everything that I could do 20 years ago. Recently, I re-roofed, insulated and texture-coated a nine-bedroom home with baths at a cost of $17,000. I have a room for two retired persons who wish to live in California. The cost is $700 to $800 per month including meals. Hope to see you next year at our 50th Reunion. . . . **Richard C. Wood** writes, "I am enjoying life immensely as a residential architect in the beautiful resort village of East Hampton, N.Y." . . .**Fleming R. Hurt** has sent a note of appreciation for the birthday greetings from the Class of 1929, adding, ". . . we will join you next June for our 50th Reunion, unless hell freezes over first." I hope this sort of spirit is contagious and many of you fence sitters are caught with it!

I had a telephone call from **Frank Mead** (August 11), one of our past presidents and the current chairman of our 50th Reunion Gift Committee who had some sad news about two of our classmates, fortunately with a happy ending. **John Wilson**, who has been a member of the M.I.T. Corporation for many years and its secretary as well, was stricken with a mild coronary last June and was hospitalized for a week or ten days, but he is home now and feeling good. John and his wife D. A. and their family were about to start a 9,500-mile trip aboard their yacht when he was stricken. John, with the help of his son, has sailed the four corners of the earth in the past. They have had many thrilling experiences, such as going through the "eye" of a hurricane which happened to them a few years ago on their way home from the island of Barbados. A detailed account was given in the *Review* at the time. Frank also informed me that **Bill Baumrucker**, president of our class, also had a mild coronary and is at the Salem, Mass., Hospital. Our indestructable Bill will not be in the hospital long as he had told Frank, "I feel great! What is all the fuss about!"

By the time you read these notes, our 50th Reunion is well on the horizon and we are on the "home stretch." Join us to make it a big event. — **Karnig S. Dinjian**, Secretary, 10 Ancient Highway at Plaice Cove, Hampton, N.H. 03842, (603)926-5363

# 30

As previously reported in the Notes, **Win Hartford** retired from Allied Chemical in 1969 and moved to a teaching job at Belmont Abbey College in Belmont, N.C., where he is currently associate professor of environmental science. From an article in *Charlotte Observer* it appears that one of Win's current projects is sparking the opposition to the proposed 55-mile belt freeway around the city of Charlotte. Using the current disillusionment with Keynesian economics as an opening gambit, Win cogently argues that the proposed Beltway would be excessively costly, would unnecessarily pave over 600 acres of Charlotte suburbs, would adversely affect the downtown area and yet would fail to provide a satisfactory solution to traffic problems. Good luck in your crusade, Win. . . . After many years we have a report from **Ludwig Jandris**, now living in South Hadley, Mass. For most of the period since he left M.I.T., interrupted by 30 months overseas with the Corps of Engineers during W.W. II, Lud worked with his father doing business as Jandris Construction Company in Gardner, Mass. In 1958, after a short stint as City Engineer in Gardner, he went to work with Daniel O'Connell's Sons in Holyoke, Mass., general contractors and engineers. His work involved the construction of schools, hospitals, commercial buildings and heavy construction, including power plants, bridges and roads. He retired in 1973. . . . Several years ago **Morris Shaffer** resigned his job as chairman of the Department of Microbiology at the Tulane Medical School and moved to the College of Medicine and Dentistry of New Jersey in Newark as dean of the Graduate School of Biomedical Sciences. It now appears that he has resigned his post at the New Jersey college and returned to New Orleans where he has re-established the family home. As of last April he reported that he was momentarily unemployed but expected soon to take up a new assignment.

**Lawrence Anderson**, who for many years was dean of the School of Architecture at M.I.T. and more recently Thomas Jefferson Professor at the University of Virginia, was the third recipient of the joint award for excellence in architectural education given by the Association of Collegiate Schools of Architecture and the American Institute of Architects. As a principal with the firm of Anderson, Beckwith and Haible from 1937 to 1973, he designed the alumni swimming pool, McCormick Hall, and other buildings at M.I.T. . . . A brief note from **Earl Ferguson** reports that he and Hilda enjoyed a great cruise on the Sitmar Line, going through the Panama Canal just after the first treaty was approved and hoping that the second one would not be disapproved while they were en route. After the cruise they spent several delightful weeks in California. . . . **Louise Dingwell** is still active as a real estate broker of residential properties in Little Compton and Newport, R.I. and Westport, Mass. . . . **Tom O'Connor** is president of Thomas O'Connor and Co., Inc., with headquarters in Cambridge and a branch office in Mamaroneck, N.Y. His company is engaged in all types of building construction and maintenance programs — particularly for industrial companies — and maintenance work on fossil fuel and nuclear power plants. In addition to running his construction company, Tom is active in oil well drilling and investment in Texas.

We have at hand a notice that **Bernie Canter** died in Springfield, Mass., on June 4. After leaving M.I.T., Bernie studied medicine at Tufts Medical School in Boston and thereafter practiced medicine for 42 years. He was a public health doctor in the Springfield school system for many years and was on the staff of the Wesson Memorial Hospital. In addition to his wife Patricia, Bernie leaves a son, Mark, of Bloomfield, Conn. and a daughter, Lois Flamm of Chatham Township, N.J. — **Gordon K. Lister**, Secretary, 530 Fifth Avenue, New York, N.Y. 10036

# 31

The Summer, 1978 newsletter of the A.S.M.E. reported that **Gordon Brown** has been jointly awarded the Rufus Oldenburger medal by the Systems Dynamics and Controls Division "in recognition for attainments in advancing the science and technology of automatic control in its formative stage". . . . **Randy Binner** reports that his two granddaughters stayed with Hope and him in June. They flew in from Minneapolis and are now ages 12 and 10 and have been flying alone since they were 5 years old. . . . **Leslie Reed** says that he retired from general contracting but keeps occupied managing apartments.

**Willis Fleisher, Jr.** writes that he sold his house and moved to a condominium in Cape Coral. Willis is concluding his second year as chairman of the Southwest Florida Chapter of SCORE (Service Corps of Retired Executives) and says that in spite of certain articles in *Fortune* and *Readers Digest* about "superannuated counselors" his experiences have given him great gratification in the results they have achieved. . . . **Emerson Brooks** has been retired from Lockheed California Co. for five years where he was an aerospace structures design specialist. He also worked on the L1011 for the F.A.A. in the last several years before retiring. . . . The Alumni Association has sent me a copy of a letter that **Charles Seaver** sent to the *Boston Herald American* regarding solar energy. Charles has come up with a new idea for heating his home next winter . . . and I'm sure we will hear more about it after he has a chance to evaluate the results.

Word has just been received of **Nicholas Fisch**'s death on April 17, 1975. Other deaths reported since our last notes are **Samuel Garre, Jr.** on April 26, 1978, **J. Firth Marquis** on June 5, 1978; and **Maurice L. Sandler** early in April, 1978. Samuel Garre, Jr. was founder and president of Pycofoam Corp. of Norristown, Penn., and was president of the Chi Epsilon Civil Engineering Honorary Society while at M.I.T. Maurice Sandler founded the Biddleford Auto Parts Co. in 1935 and later purchased the American Gear Co.; he combined the stores in the 1960s under the name United Auto Parts Co. Our deepest sympathy to their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; Assistant Secretaries: **Ben W. Steverman**, 260 Morrison Dr., Pittsburgh, Penn. 15216, and **John R. Swanton**, 27 George St., Newton, Mass. 02158

# 32

At the June alumni luncheon I had an opportunity to talk with **Douglas Miller** of Hartford, Conn. For the last 15 years he has been a highway design engineer for the Department of Transportation in the Bureau of Highways. He retired in June, 1977, and is now studying real estate. He and his wife, Rena, are occupied with church and house activities. They travel each year, last year to Colorado, this year to New Orleans. They have two married children, Robert Miller and Sally Johnson.

**George Daniels** of Quincy, Mass., also attended the reunion. He was a marine engineer for 30 years with the Bethlehem Steel Co. Three years ago he had a heart attack and never went back to work. He likes to sail with his wife Margaret around the Cape in the summer. They have two sons — one in Rochester and one in Barnstable.

**Harold Tonsing** of Weymouth, Mass., tells me that during the war years he worked as an architect engineer on camp construction. His main work was on Camp Robertson, Little Rock, Ark. For the next 27 years he was busy at M.I.T. working with electronic systems and servomechanisms. He particularly enjoyed working with students on various projects. He has been retired since 1970. Time passes pleasantly for him and his wife Verda. They have a daughter in New York.

We have received notice that Dr. **Harry Shwachman**, who received his S.B. from M.I.T. and his M.D. from Johns Hopkins Medical School, is presently Professor Emeritus of Pediatrics at Harvard Medical School. He has written countless articles on cystic fibrosis. He recently conducted a seminar on this subject at the St. Joseph Hospital in Bangor, Maine.

**Russell S. Robinson** writes us that although he has a great-grandson he still feels like a boy himself. This summer he and his wife are fleeing from the high heat of Tucson and circling the United States and Canada, with an especially long stay in Canada's maritime provinces.

**Dirwood M. Danforth** is retired and enjoying his new home as of March, 1978. . . .**Lester Glickman** retired from the Navy Department four years ago. His last assignment was in Newport, R.I., where he was Director of the Quality Engineering and Evaluation Laboratory of the Naval Underwater Systems Center. At present he is living in North Miami Beach, Fla., in a pleasant condominium complex called "Aventura." He is active in the M.I.T. Alumni Club of Southern Florida where he occasionally sees another "'32er", **Bob Nordlinger**. They are hoping to attend our 50th Reunion.

**Albert W. Dunning** is still active at Dunning Associates. He is looking forward to retirement at the Cape with golf, fishing and boating. . . . **Stan Johnson** became fed up with two years of retirement and now puts in a 40-hour work week. He is on the construction supervision staff of the engineering firm U.R.S./Madigan-Praeger, Inc.

We have just received word that **Robert M. Jackson**, Sarasota, Fla., died in December, 1977, and that **John A. Hagen** of Silver Springs, Md., died in June, 1974. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass.

# 33

**Warren Henderson**, Secretary of the Class, is recovering from an illness which had him tempor-

**William A. Baker Commissioned to Help Save the "Ernestina"**

The lifelong interest in ships and their history which has motivated William A. Baker, '34, through a career in shipbuilding at Bethlehem Steel Co. and maritime history at M.I.T. has a new object: the schooner "Ernestina," now lying at anchor in the Cape Verde Islands.

The "Ernestina" was launched in 1894 in Essex, Mass., as the "Effie M. Morrissey," and under that name she made many trips to the arctic as a supply vessel between 1926 and 1946. Two years later she began a 17-year career under her present name as a packet ship sailing from the Cape Verde Islands to the New Bedford, Mass., area; she was the last immigrant packet ship to the U.S. under sail.

Now the government of the Cape Verde Islands would like to give "Ernestina" to the U.S., and the National Trust would like to restore and exhibit her. To that end, Massachusetts' Governor Michael Dukakis has appointed Mr. Baker and four other New England maritime historians to a Commission assigned to save what the Governor calls "an important symbol of the Cape Verdean heritage."

To return the "Ernestina" to the U.S. may cost $50,000, and repairs, restoration, and refurbishing may cost $200,000.

arily in the hospital in August — the reason for the absence of class news this month. We are, however, happy to report that he has now returned home and that the class notes will resume as usual in the November issue. Mail will still reach Mr. Henderson at Fort Rock Farm, Drawer H, Exeter, N.H. 03833. We wish him a complete and speedy recovery. — *S. K.*

# 34

It is possible to sit down to these notes with a better frame of mind than the last ones. True, there are some losses to report, but they are relieved by notes and information from classmates who are still with us.

From my very parochial viewpoint I always appreciate the releases from large companies when one of their executives retires. They always tell what the person has been doing over the years — things the individual rarely bothers to pass on to a poor class secretary — and are far more pleasant to read than obituaries. Thus, I appreciate the write-up from Amoco Oil Co. on the occasion of **Art Conn**'s retirement last April from his position of Director of Government Contracts. Art had completed 39 years of service with Amoco, starting in their research department in 1939. He had followed a diversified career in various aspects of petroleum refining, had been in charge of the company's part in the Manhattan Project and then found his way into government and outside contract works. In recent years he has been active in problems of energy planning and the development of synthetic fuels; this included chairing a National Academy of Engineering committee on refining coal and shale liquids and serving as a consultant to the Office of Coal Research. In 1970, Art was President of the American Institute of Chemical Engineers and was active in other professional societies. Just to keep his hand in, after retirement, he has formed Arthur L. Conn and Associates, Ltd., specializing in the fields of energy, management and information. All of the above reflects great credit on Art, but they forgot about the thing many of us remember best about him — he was a mean banjo player with the Musical Clubs when he was at Tech.

An honor and an indication of continued public service is the announcement in June that **Henry A. Morss, Jr.**, was elected a trustee of the Woods Hole Oceanographic Institution here on the Cape.

I do have to report the loss of two members. One, **Winston W. Ehrmann** died in June in Mt. Vernon, Iowa. Dr. Ehrmann had started at M.I.T., then moved to Yale for his undergraduate and graduate degrees. During World War II he was a military observer for intelligence work in India and Burma. He attained the rank of colonel in the Corps of Engineers and was awarded the Bronze Star. After the war he was an industrial engineer with U.S. Rubber Co., taught at the University of Florida and Colorado State University, and served on the staff of the American Association of University Professors. He joined the Cornell College as Professor of Socioiogy in 1966, became Dean of the College in 1969 and served as provost from 1975 until his retirement in 1977. Dr. Ehrmann is survived by his widow, Margaret, two daughters and a twin brother.

Our other loss is that of **Harry W. Fox** who was unfortunately killed in an automobile accident in Virginia last May. He had moved to Washington, D.C., in 1942 when he joined the Naval Research Laboratory as a senior chemist and remained there until 1955. At that time he moved to the chemistry program of the Office of Naval Research, eventually becoming its director before retiring in 1972. Mr. Fox was active in Temple Micah and was travelling to a retreat sponsored by it when his fatal accident occurred. He is survived by his brother Bernard and a sister, Ruth Kreisman of Malden.

To both families on behalf of the class, I would extend our sympathies and regrets.

Information continues to come in through the Alumni Fund responses. **Karl A. Gardner** writes, "I retired from Atomics International at the end of August 1977. Have since been active as an engineering consultant on heat transfer equipment and heat transfer per se. Clients include Tubular Exchanger Manufacturers' Assoc. (T.E.M.A.) and Heat Transfer Research, Inc. (H.T.R.I.) as well as individual manufacturers and users."

*Art Conn, '34*

From north of the border **Katherine S. Lemon (Seidensticker)** says, "Ivar and I are still enjoying retirement from active farming. Camping in Florida in the winter, sailing in Sweden in the summer. Frequent visits from our three children and their families — six grandchildren all told." It sounds very nice, but when do the children find the Lemons home?

**Arthur B. Fox** notes briefly, "Co-founder of a new electronics company, Octek, Inc., June 1978 in Burlington, Mass. Specializing in automated image analysis." . . . From **W. Quentin Smith**, "Retired from the DuPont Company in 1974. Recently retired as the Dean of Occupational and Technical Studies at the Parkersburg, W. Va., Community College." . . . To finish on an up-beat note, **Willard D. Chandler, Jr.** writes, "On May 13, 1978, I married Dorothy Lou Molloy, daughter of the late Dr. Earl D. McBride who founded the McBride Clinic and Hospital here in Oklahoma City many years ago. At age 65 I'm still looking forward to a long, happy life with her." I'm sure we all join in an "amen to that" and wish Will and Dorothy many good years. — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, Md. 20015

# 35

I have a letter from **Ham Dow** who has finally, with Edith, found their new home ground: "It's a year since I retired from General Electric's Nuclear Energy Group, and there has not been a new reactor sold since. Now after wandering, exploring, and scouting various places against the specifications of (1) winters a bit milder than San Jose, (2) summers no hotter and with the same cooling afternoon and evening breezes, and (3) convenient proximity to Kaiser/Permanente Foundation Health Plan facilities in which we are members, Edith and I believe we have found the ideal home for us to set our roots. During the last year we have looked at places like Oceanside, Lake San Marcos, Mission Viejo, Laguna Hills, Carlsbad, LaJolla, Escondido, San Clemente, Ramona, El Cajon, Del Mar, Solana Beach, La Costa, and Rancho Santa Fe: finally we have chosen Rancho Bernardo as best meeting our criteria." Their new address is 12349 Filera Rd., Rancho Bernardo, San Diego, Calif., 92128, telephone (714) 487-8222. We all wish you happiness and well-nourished roots. . . . **H. William Parker** joined the Class "tour" this year and reports that his daughter-in-law gave birth to a new grandson (number four for the Parkers, along with two granddaughters). . . . **Paul Gilmont** wrote from Cypress, Calif., that he retired in April and now has reason to believe he's always been allergic to work. "I have had a little sloop (*Cal 20*) down at the Long Beach Marina these past 15 years and used to race it in class (not too successfully). Now both boat and I enjoy seeing each other more frequently (it just bounces at its mooring when it sees me coming). I cleaned my golf clubs but haven't tried to swing them yet. But I promise I will practice and enter next year in the Class Hacker

contest." We better watch out, for Paul is another who has had a by-pass operation along with Leo, **Dick Bailey** and me. We've all picked up 20 years of energy and vitality.

**William Buechner** has retired after 37 years on the M.I.T. faculty. . . . **Clark Nichols** was elected Fellow in the I.E.E.E. "for contributions to and leadership in the design of computer-control systems for electric power applications."

We have just received notice of the death of **Arthur Riehl** in Seattle on April 24, 1977. Arthur was in Course IV. We are sending a belated message of sympathy to his family.

The 18th annual golf tournament has gone through the first two rounds, and one of the latest casualties is last year's champion, Fran Muldowney. **Ken Finlayson** retired me early, and some others who bit the dust are **Leo Beckwith, Dick Bailey, Sid Grazi,** and **Hal Bemis**. By the time you read this we should at least know who the finalists are. Now if some of you nongolfers would just take the time to write me a letter, it would please not only me but other nongolfers all through the class. I would love to hear from such disparate places as Bath, Maine; Hanover, N.H.; Bellevue, Wash.; and St. Petersburg, Fla. How about it? — **Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

# 36

First, the sad news: **John J.C. Coffin** of Amesbury, Mass. died last April 14th while vacationing in Virginia. Jack had spent all his working years with the Towle Manufacturing Company in Newburyport. He had retired in 1976. He is survived by his wife, Priscilla, two daughters, a granddaughter and a brother. To his family, the class extends sympathy.

A note from Zee Kanters brought the sad news that **Larry Kanters** succumbed to cancer on July 25th after a year and a half of trouble. He had recovered well from surgery for a lung tumor in 1975 but required brain surgery in May of 1977. He was a vice president of Gamble-Skogmo, Inc. in Minneapolis and previously had been associated with Kaufman's and Horne's in Pittsburgh. Virtually all of his working life had been spent in retailing, mainly clothing. Besides his wife Zelia, he is survived by two sons and two daughters and several grandchildren. Larry and Zee had moved a year ago from their house on Lake Harriet to Edina (5212 Malibu Dr, Edina, Minn. 55436). To Zee and her family go our sincere sympathy.

Now for the happier news: **Henry McGrath** spent last March in Western Europe studying coal technology which could be commercialized here before 1990, under the aegis of the U.S. Department of Energy. He reports that he and Mildred met the **Py Williams** at a French restaurant in Great Falls, Va. Whether by design or accident Henry didn't say. . . . **Louis Stahl** has been promoted to chairman of Beatrice Foods Company's Chemical Division. He joined the company in 1965 when his Stahl Chemical merged with Beatrice Foods. . . . **Ron Beckman** writes from Marathon, Fl., that he spent the month of May in Europe visiting seven countries and seeing enough ancient ruins, cathedrals, and castles to "last a lifetime".

By the time you read this **Roger Krey** will know whether he survived a primary contest to become the Republican candidate for Representative to the General Court of New Hampshire. His home is is Mirror Lake. . . . A note From **Fred MacDonald** in Scituate, Mass., contained a clipping from the *South Shore News* on last March 22nd. It describes a new house for which MacDonald designed a cement foundation and deck which protected the home from the onslaught of the Blizzard of '78 while its neighbors' houses crumbled . . . . **Richard Farmer**'s retirement from the positions of Production Manager of Smith Douglas Division of Borden Chemical and President of Illinois Nitrogen took effect in September. What he plans to do in his retirement he doesn't divulge . . . . **John Fluke** has been elected a Fellow of the I.E.E.E. "for contributions to electronic instrumentation."

If you read these notes in time, remember that your secretary will be delighted to welcome you for a mini reunion on Saturday, October 28th. — Alice H. Kimball, Secretary, P. O. Box 31, West Hartland, Conn. 06091

# 37

**Earl Fraser** has changed jobs. He retired from Sacramento County Civil Service after 23 years, 21 as Planning Director, and is now active as a consultant for local public agencies and developers, up to half time. He still skis, plays tennis and trains and hunts with Brittany Spaniels. . . . **Eric Swenson** writes that four steamship companies, one shipyard and finally the American Bureau of Shipping (34 years) have kept him busy since graduation till retirement at the end of April this year. . . . **Phil Dreissigacker** is still with Farrell Co., Division of U.S.M. Corp. He sent a clipping in regard to the recent death of **William H. Austin** in Chesire, Conn. Bill was the owner of the William H. Austin Associates, engineering consultants. Our sympathy goes to his wife Margaret, and their family. — **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester Klashman,** Asst. Secretary, 198 Maple St., Malden Mass. 02148

# 38

The 40th Reunion was a smash success looked at in retrospect, judging by the many comments I have received. Typical is a note from **John Petroskas**: "The 40th Reunion was a joy. I was looking forward to meeting some classmates that did not come, but let's hope all of us can make the next one."

**Dave Wadleigh**, our new Class President, has sent out a questionnaire to those attending asking if a mini-reunion two or three years from now would be of interest. So you have any thoughts on this? If so, drop a line to Dave or myself. One possibility, considering the number of us who have retired or will retire soon, would be to hold an informal reunion in March of 1980 or 1981 in Mexico as part of the annual Fiesta put on by the M.I.T. Club of Mexico City. I've been fortunate enough to have attended several in the past, and can recommend this as a mini-reunion in an unusual (but nevertheless an M.I.T.) setting.

**Nicholas Barbarossa** will spend one month in Pakistan as a water resources consultant to Harza Engineering Co. to assist in preparation of a comprehensive flood management plan for the government of Pakistan. . . . **Horace Homer** has been promoted to senior scientist just in time to take early retirement this fall.

It took a class telethon call to learn that **Mike Cettei** passed away last November — no further details are available. — **A. L. Bruneau, Jr.**, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

# 40

*No Moss.* Retired last year from Greenfield Tap and Die, **Robert S. Harper** is continuing as a director of Franklin County Trust Co. and working on special projects for the University of Massachusetts School of Business Administration.

*Desert Sands.* **John H. McQuilkin**, of Bechtel Corp. is back from two years in Saudi Arabia.

*Distinction.* **W. Kenneth Davis**, Vice President of Bechtel Power Corp. has been elected vice president of the National Academy of Engineering for a four-year term. Davis will also serve as a member of the governing board of the National Research Council. He and his wife Margaret, a pianist and composer, make their home in San Rafael and Tahoe City, Calif.

*Two Hats.* **Oliver H. Fulton**, Executive Director of the Maryland Industrial Development Financing Authority, is now president of the M.I.T. Alumni Club of Maryland. **Charles A. (Andy) Stokes** is consulting with his Stokes Consulting Group in Naples Fla., on energy matters — and manufac-

**How to Beat Inflation While in Retirement**

It all began in 1974, when Lester H. Moffatt, '35, decided on early retirement after a 35-year career with General Dynamics. What could he do to protect his retirement income from the ravages of inflation, "which our elected representatives have not indicated the courage or inclination to arrest"?

Mr. Moffatt's worries went this way: an inflation rate of only 6 per cent would result in a doubling of prices every 12 years. His Social Security income was indexed to inflation — that would keep pace. The value of his pension was fixed; relying on that part of his income, he would lose ground every year. The same problem with his savings — and probably with his stocks and bonds.

But his house: building costs have been going up at a rate 1.5 times the general inflation rate. If they continue to do so — and Mr. Moffatt's research suggests they will — a home can be vital "inflation insurance," and on this concept Mr. Moffatt has built a consulting practice which he calls "Inflation-Guard Service" and written a book, "Protect Your Retirement Income Against Inflation," which he sells for $7.95 (Box 10138, Fort Worth, Texas 76114).

In a nutshell, Mr. Moffatt tells retirees to stay in the big house in which the family was raised as long as they can; it's the fastest-growing investment they have. When they finally sell, their retirement fund will gain an infusion of capital far larger than it would have had if the sale had been made five or ten years earlier.

Computer-based plans to help retirees plan future income and to capitalize on this idea are now Mr. Moffatt's specialty, and his book contains examples and sample budgets to show how it works. Mr. Moffatt makes it clear that he's not an economist; his primary concern is not with economic predictions for the future. Instead, he says, his is "an engineering approach to personal financial planning assuming inflation keeps on indefinitely." — J. M.

**Bergeson: Searching for His Roots on a Solo Sail from Maine to Norway**

Lloyd Bergeson, '38, missed his 40th reunion at M.I.T. last June: he was already on the high seas, starting a lonely sail on his Herreshoff-designed, 70-year-old 43-foot sloop from Isle au Haut, Maine, to Stavanger, Norway.

It was a long-planned search for his roots. The Bergeson ancestors were Norwegian fishermen and traders, and Lloyd Bergeson's grandfather brought his family to the New World on a 42-foot sailboat in 1853. Now Lloyd wanted to "return the favor," and after his 3,000-mile solo crossing and a week of being the "toast of the town" in Stavanger he spent most of the summer exploring the rugged coast of Norway and the Lofoton Islands.

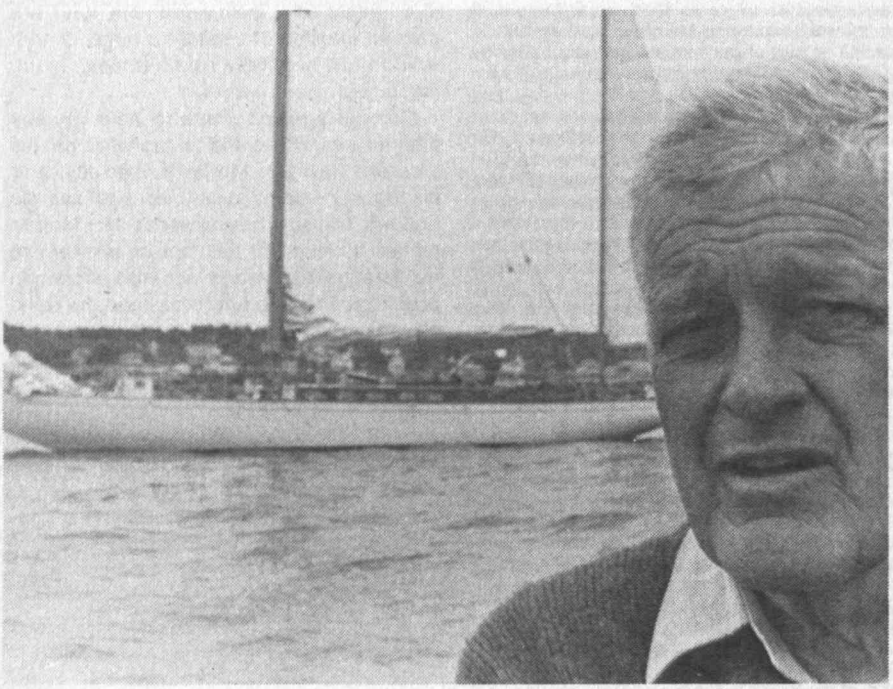
Mr. Bergeson has owned *Cockatoo II* for 22 years, and he's done most of the repairs and restoration himself. The boat is familiar to many East Coast yachtsmen — one of the few of its age still sailing and racing; "I've cleaned up a lot of silver in New York Yacht Club races," Mr. Bergeson admitted in an interview before leaving Maine last June. For the crossing, *Cockatoo II* was modified with yawl — instead of sloop — rigging, and Mr Bergeson himself designed a self-steering system to deal with the strong winds and cold nights of the North Atlantic.

*Front-Page News in Norway*

When he set sail from Isle au Haut, Mr. Bergeson gave himself "a month plus or minus ten days" to reach his destination, and that was just right — from June 5 to July 6. The crossing was made eventful — and worrisome for Mrs. Bergeson — by failure of most of the electronics aboard *Cockatoo II*, but there were no serious problems. Its arrival was front-page news in Norway.

Mr. Bergeson has pursued an active career in naval architecture since graduating from M.I.T., working at various times at the Fore River Shipyard, Bath Iron Works, and Ingalls Shipbuilding Co. (Pascagoula, Miss.). He was in charge of design and construction of the first U.S. Polaris submarine while with General Dynamic's Electric Boat Division and was assistant manager of the U.S. Atomic Energy Commission's Hanford operations. He now works as a consultant to the industry from his home in Norwell, Mass.

Late in the summer, when this was written, Mr. Bergeson's plans for returning from Norway with *Cockatoo II* were not yet definite — perhaps next summer, replicating grandfather Ur Bergeson's westbound trip of 1853?



*It took Lloyd Bergeson, '38, one month to make a solo trans-Atlantic sail from Isle au Haut, Maine, to Stavanger, Norway, in the* Cockatoo II. *The trip was a smooth one, with all equipment, including the self-steering vane, working properly. Two days out from Isle au Haut, a Fulmer gull came aboard and stayed the entire voyage. "At least," said Mrs. Bergeson, "Lloyd had someone to talk to." (Photo: Denis Thoet,* Island Ad-Vantages)

turing methanol with his new California Energy Chemical Co.

*Cross-country Shuttle.* **Donald M. Cole, Jr.** late of La Habra, Calif., has moved to Huntsville, Ala. for a year's work on Rockwell's space shuttle vibration test program.

*Tech Day '78.* For the second year in a row **Leo Pach** has attended Tech Day as a '40 alumnus. He found as few this year as last from the Class of 1940.

*M.I.T. Corporation News.* **W.H. Krome George** of Pittsburgh, Chairman and Chief Executive Officer of the Aluminum Company of America and **I.M. Pei**, fresh from his completion of the new Mellon wing of the National Gallery of Art, were elected Members for five-year terms — the second in a row for each.

*Over the Bar.* The alumni office has sent word of the death of **Thomas D. Kroner** in Marblehead, Mass. — **Frank A. Yett**, Secretary, P.O. Box 562, Long Beach, Wash. 98631

# 41

Once again **Ralph Landau**, Chairman of the Board for Halcon, International, has been honored for his outstanding entrepreneurial achievements. This time it was by the Newcomen Society in North America at a gala dinner in The Hotel Pierre. The giants of the chemical industry attended. Congratulations Ralph! . . . General **Tirso G. Fajardo** retired as Commanding General of the Philippine Army in Manilla . . . We heard from **Les Corsa** whom we knew as a Chemical Engineer, informing us that he is entering his 14th year as Professor of Population Planning at the University of Michigan, and publishing this year (with Deborah Oakley) the first worldwide synthesis of our new field in a book, *Population Planning*, by U. M. Press. He also had a suggestion: "Order your copy now to remain an informed responsible world citizen!".

**Al Bensusan** tells us he is in the process of forming a consulting service for the jewelry and related industries called Jewelry Engineering Associates. . . . **John Porter** has retired from N.O.A.A. Weather Serice. . . . **Peter Homack**, President of Elson T. Killam Associates, Inc., received a Doctor of Engineering honorary degree from the New Jersey Institute of Technology. . . . **Bill Cherry** writes, "I could write a little or a lot about the adventures of a physicist in politics and in local government and about attempts to save the two-party system, especially the nearly defunct Republican Party." . . . Harold Richards, Jr., who is Manager of Retail Sales for Exxon Co. U.S.A. in Memphis, Tenn., informs us that six members of Chemical Engineering Practice School, Class 1A-40, from Class of 1941 had a reunion in this home.

The American Academy of Arts and Sciences elected Dr. **George Hoagland Vineyard** to membership. It's interesting to note that 20 per cent of the total membership of the National Academy of Science and the National Academy of Engineers are M.I.T. alumni. If you include M.I.T. professors who are not alumni the percent of M.I.T. related members is higher. Keep sending in your news. — **Henry Avery**, Secretary, U.S.S. Chemicals, 600 Grant St., Suite 2858, Pittsburgh, Penn. 15230

# 44

In case you missed the details of the 35th Reunion in Bermuda in the August/September issue of *Technology Review*, **Norm Sebell**, reunion chairman, has requested that all classmates be notified of our plans by direct mail. Naturally, Norm and the committee expect everybody to join us at Castle Harbour Hotel, Beach and Golf Club, June 9-13, 1979. Hope to see *you* there.

During the year or so between his job at N.B.C. Television as Vice President of Sports and his new position of Vice President, Programs, for C.B.S. Sports, **Carl Lindemann, Jr.** served as a consultant to the N.Y. Olympic Project as producer of the N.H.L. network. We were always pleased to see Carl's name during the "crawl" after the Bowl games and the Series. The stories

he must be able to tell! Maybe we can hear some at a reunion if he can ever break away. Starting in 1948, right out of M.I.T., with early camera work when TV was all live: the Kate Smith Show, Today Show, — yes, we'll have to hear about these some time. It seemed natural that he'd go into sports. Throughout his military service, he (and **Sam Parkinson**) could be counted on to turn a five minute break into a combination sunbath and athletic exercise. He and Marguerite now live in New York and their five children are off on their own: Carl III, the youngest, is a senior at his father's alma mater, Phillips Exeter; Mary Allen is at Bowdoin; Frances graduated from Sarah Lawrence this year; Catherine and Sarah, the two oldest, are out of school. Now we can look forward to viewing the results of Carl's efforts at C.B.S. Good luck, Carl.

In the New England news, we read that **Ralph Seferian**, who manages new ventures for the Cabot Corp., has been elected a director of the Boston chapter of the North American Society for Corporate Planning. For the past half dozen years, Ralph has been in charge of new business experiments, venture capital investments, economic research, and the evaluation of mergers and acquisition.

Dr. **Sanborn C. Brown** has just written a new book that should appeal to many of us and might help toward our next reunion. Recently published by the University Press of New England, it's titled: *Wines and Beers of Old New England, a How-to-Do-it History*.

This summer, M.I.T. presented a program on *Integrated System Dynamics and Network Thermodynamics* for research scientists and engineers from university, industry and government. The program director was Dr. **Henry M. Paynter**, Professor of Mechanical Engineering at M.I.T. During his distinguished career at M.I.T., Professor Paynter has been an apostle of Systems Engineering; his book has become a classic.

*Flap Facts*: **Walt Turner** ("Doc" to you Shaftees) writes that his third offspring (of four), who received his B.A. in economics from Oberlin, will enter M.I.T. graduate school this fall on an N.S.F. Fellowship. . . . **Richard F. Cross III** has formed a small company, R. F. Cross Associates, Ltd., in Alexandria, Va. They do management analysis and research primarily for the Department of Defense. . . . **Randall N. Pratt** and Florence Felde Beutler were married in June 1977. He is a member of the profesional staff at the University of Delaware, Newark, as an Engineering Computation Specialist.

**John Hull**, our Class President, writes to tell how much he and Buz enjoyed the 34th Reunion in Virginia. At the same time, he urges all classmates to plan to attend the 35th in Bermuda in 1979. — **Melissa** and **Newton Teixeira**, Co-Secretaries, 92 Webster Pk., West Newton, Mass., 02165

# 45

Surprise! Your wayward Class Secretary has returned! Goodness knows when you last saw your class in print, and we hope you neither ask nor check your back issues.

For the past 18 months I've been operating out of Rhode Island rather than Boston as Allendale Insurance's International Sales Manager. Between the New Hampshire-Rhode Island commute (and it is not daily!), regular trips about the country and Europe, etc., this responsibility has suffered. Hopefully, we can make amends in the months ahead. A week ago today (July 30) Fran and I completed a restful "Down East" cruise aboard our Tartan 27 with Lou and **Pete Hickey** — a repeat of a four-dayer in '77. The four of us have had such fun these past two years that we hope it will become an annual affair. As for Pete, he thoroughly enjoys being back in New England after a 25-year sabbatical in New Jersey — first with **John J. Evans** in Camden and then Seton Leather in Newark. As you might expect, it is still the leather business, now in Peabody. Pete and Lou do miss the old family Harwich port retreat which Pete's father sold some years ago.

Pete's fellow Phi Gam, **Vince Butler**, was — amongst others — a conversation subject during our cruise. Would you believe that Vince called me here at home about 6:00 a.m. last Monday to report that he had just finished — 3:00 a.m. his time — a phone conversation with one of his old high school classmates, Pierre Salanger. Vince is not only the principal owner of the local country club in Santa Cruz, but also serves as mower, groundskeeper, chef, pool cleaner and the like as conditions dictate. In contrast, his wife, Bobbie, spends half her time travelling about California as an interior decorator. Vince continues as a Captain, U.S.N.R. with some 35 years (yes, it was the spring of 1943!) accredited service under his belt — and you and I will be paying his pension! Vince reports that he had recently heard from **Julian Busby**, our Oklahoma wildcatter, advising that he had just hit a gusher. Let's hope so! As I was in Europe at the time, daughter Betsy, Smith, '78, joined Fran as the Springer representatives at Tech Nite at the Pops. Although I have no official count on 1978 Alumni Days attendees, the following were at Symphony Hall: New grandparents **McNamara**'s, the **Chuck Patterson**'s, **Jerry Quinnan**'s, **Bob Maglathlin**'s, **Jim Pickel**'s and **Charlie Hart**'s.

Several classmates have forwarded considerable information on their whereabouts as an enclosure to their Alumni Fund gifts, so here we go. From Marie A. Jackus in February: "I have just retired from the National Institute of Health, and in December I moved from Bethesda, Md to San Diego where I am slowly adjusting to a different world." . . . A note from Princeton's **Art Miller** forwarding a *New York Times* book review on "Trouble with Dragons!", a modern tongue-in-cheek fairy tale by **Oliver G. Selfridge** who you will recall was either a Math or Physics major. . . . **David G. Meckley**'s business address is: The William H. Ottemiller Company, 386 Patterson St., York, Penn. . . . **Jack B. Skinner** advises that he has been working for Aerosonic Corporation for the past 15 years.

Congratulations to **Emily V. (Paddy) Wade** as District 2 — Boston — Director of the Alumni Association for the years July '78-'80. . . . **William K. Linvill** of the Department of Engineering — Economic Systems at Stanford University presented a paper entitled "The University Role in Exploring Societal Choices of Technology" at the A.A.A.S. annual meeting last February. . . . Last November **Matthew T.. Lebenbaum** was named Vice President of Applied Electronics Division at Cutler Hammer's AIL Division in Deer Park, N.Y. Lebenbaum received his M.S.E.E. with us while serving with the Radio Research Lab at Harvard during our undergraduate years. . . . **Frieda Omansky Cohen** continues her busy pace with deep involvement at the moment on the Committee on Visual Arts after time with the Ellen Swallow Richard's Professor Committee. Son Richard, '76, not only helped Frieda become a grandmother but continues research at M.I.T. as a resident at Peter Bent Brigham Hospital. Steve, '70, does marketing for Hewlett Packard in California, whereas other offspring are involved in both graduate and undergraduate work at Harvard.

Rev. **Charles J. Hooker, Jr.** was recently appointed Emergency Coordinator for U.S. Army Military Affiliate Radio Systems (MARS) for Pennsylvania. Charlie assisted the National Guard and Red Cross in disaster communications during the Johnstown flood disaster in 1977. . . . Last November **Don Lovell**, our optics expert at the University of Massachusetts in Amherst, was giving expert court testimony regarding the hazards of highway advertising signs. Unfortunately, we have not seen the demise of these ugly signs. Don continues his work in optical instrumentation at cryogenic temperatures. . . . **Mrs. Norma Satten**, as a partner in Kaiser/Satler Associates, is engaged in health and human resources planning research and evaluation. . . . **Harry W. Mergler**, Leonard Case Professor of Electrical Engineering at Case Western Reserve University in Cleveland, has been named the 1978 Lamme Medal Recipient as awarded by the I.E.E.E. A great accomplishment when one realizes the Medal bears the inscription "The Engineer views hopefully the hitherto unattainable" and Harry's award reads "For pioneering research and creative industrial application of digital technology to machine tool and industrial control systems". The Mergler's reside in West Lake , Ohio. Their children, Myra, Marcia and Harry F. are respectively a doctoral candidate at the University of Nebraska, a recent graduate of The American Graduate School of International Management, and a junior at the College of Wooster.

Captain **William D. Roseborough, Jr.** continues with the Electro-Optical Division of Rollmonger Corporation, Northampton, Mass. where he maintains active Institute contact as Program Manager of the Agency for International Development's grant to M.I.T. to support a Technology Adaptation Program. This particular program concerns itself with the problems of industrial technology in the lesser developed countries. . . . The **J. J. Strnad**'s 1978 Valentine card would suggest that Jeff has about wrapped up his work at Yale Law; Lyse continues her medical studies at Case Western Reserve while doing some off-campus research in Pathology this year. Nina is back at Harvard, Edna continues as Director of Development at Hathaway Brown School, and, oh yes, the ole' man keeps Lempco Industries a'running.

Talk about being up-to-date, I've just stumbled upon a **George Upton** profile dated September, 1977, that **Nick Mumford** thoughtfully forwarded last Christmas. The Vought Corporation profile discussed the company's V/STOL design that was submitted to the U.S. Navy in mid 1977. Yes, the design was developed by a team headed by one George Upton. We trust that Nick Mumford continues with LTV, but late last year Nick elected to remain in Michigan rather than return to Dallas with his Division, and we all know what such a decision can do within our corporate giants. Rumor has it that the **Jim Brayton**'s are building a retreat in Little Compton, R. I.

**George** — no longer Curly — **Bickford** continues at Carrier in Syracuse as Manager — Physical Distribution which in layman's terms means George runs the worldwide, highly automated warehouse operation. George continues his ski activities but he has not mentioned within the past couple of years ski patrol activity. After a lifetime in New York — 20 years in Manhattan and about 30 in Binghampton — the **Jerry Patterson**'s are dyed-in-the-wool Texans, and only after two years. Jerry, as you know, is in the steel fabrication business in Fort Worth.

Whew! A year's accumulation has bitten the dust — all because it is a hot, humid, rainy August Sunday here in New Castle. Have a Happy Thanksgiving and we shall return to wish you Season's Greetings. — **C. H. Springer**, Secretary, Box 288, New Castle, N.H. 03854

# 46

**David G. Black, Jr.** formerly Research Corporation's regional grannts director in Providence, R. I., has recently been elected Corporate Secretary and has assumed his new duties at the Foundations's headquarters in New York. He will coordinate the work of the Foundation's Board of Directors and its professional staffs in grants and in invention administration. Dave and his wife and family have moved to 133 Pelhamdale Ave., Pelham, N. Y. The Research Corp. provides grant support for fundamental work in the sciences through encouraging the development and use of new university inventions.

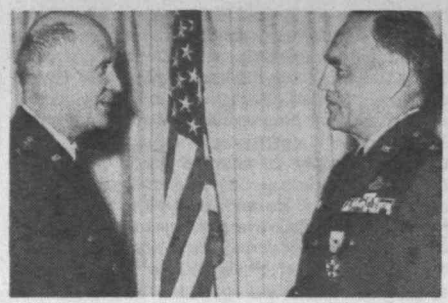
**Lewis T. Mann, Jr.** sent a short note with a recent Alumni Fund contribution. The Manns live in Fresno, Calif., where he has fun as Associate Professor at California State University for the sum of $1 per year. Lewis and his wife are busy on the local school committee and enjoy cross-country skiing in the Sierras.

**John L. Norton** advises he and his wife, Priscilla, are still living in Greensville, S. C., where John, after 21 years with General Electric, is Test Manager for G.E.'s large gas turbine plants.

**Jim Craig** and his fellow developer, Austin

David Black, '46

John Mather, '47



*Air Force Reserve Major General Vincent S. Haneman, Jr., (left), receives a second award of the Legion of Merit during ceremonies at the Pentagon from veteran Astronaut Lieutenant General Thomas P. Stafford, Deputy Chief of Staff for Research and Development. (U.S. Air Force Photo)*

Heath, are working to advance their plan to construct a new 800-to-1,200-room convention hotel in Boston. The basic hotel and trade center to be built along Atlantic Avenue near the Aquarium. Jim and his group are now developing a condominium on Union Wharf in Boston and they have collaborated on designs for Hyatt Regency Hotels in Toronto and Vancouver, the Inn on the Park Hotels in Toronto, Ottawa, and London (Ontario), and Hilton Hotels in Toronto and Quebec City.

**David G. Hoag** has written an important article for the May, 1978 issue of *Astronautics and Aeronautics*, "Strategic Ballistic Missile Guidance — A Story of Ever Greater Accuracy." Dave heads the Advanced Systems Department of Draper Laboratory. From 1958 to 1961 he was technical director for M.I.T.'s development of the guidance system for the Navy Polaris missile, and from 1961 to 1966 he was the technical director of the M.I.T. Instrumentation Laboratory and later program manager for that Laboratory's development of the guidance, navigation and control system for the Apollo spacecraft.

Two 1946 class members, **Felix F. Browder** and **Melvin Friedman**, were elected to Fellowships in the American Association for the Advancement of Science in February, 1978 — **Russ Dostal**, 18837 Palm Cir., Cleveland, Ohio, 44126

# 47

Dr. **John R. Mather**, Chairperson and Professor of Geography at the University of Delaware, is the new Delaware state climatologist. His involvement includes collection, processing, publication, storage, analysis, and use of weather data. He will also serve as a consultant. John has been at the University since 1961, and has authored more than 80 technical papers on climatology and related fields, and at least two books, including the current *The Climatic Water Budget In Environment Analysis*, Lexington Books. In the intervening years, John has taught at John Hopkins and Drexel Universities and the University of Chicago. He was a research associate and climatologist at the Laboratory of Climatology in Seabrook, N.J., and president of the C.W. Thornwaite Associates Laboratory of Climatology, Centerton, N.J., from 1963-72, and principal research scientist there. He is a former technical expert to the United Nations World Meteorological Organization in the United States and Yugoslavia, and has been cited in "Who's Who in Science" and "Who's Who in America" for his contributions to the study of potential evotranspiration and hydrology, climatology and geography. He is a member of Tau Beta Pi, Sigma Xi, the American Meteorological Society, the Association of American Geographers, the American Geophysical Union, and the American Geographical Society.

Last February, while we in the Northeast were in the middle of our climatological dilemma, **Donald Dean** was trying to keep cool. He writes: "Made the M.I.T. Tour to the Mid-East in February, 1978: a 12-day cruise out of Athens via Israel and through the Suez Canal."

The third annual colloquium on research and development policy of the American Association for the Advancement of Science focused on the role of industrial and federally-funded research in support of the economy. Noted was the sharp shift away from long-range research goals in favor of shorter-term objectives of cost reduction and new product development, and "defensive" research to cope with increasing government safety standards. **Jordan Baruch**, Assistant Secretary of Commerce for Science and Technology, heads the committee (formed under White House auspices) to review problems related to industrial innovation, focusing on the factors which control a company's ability to innovate and those affecting its decision to do so. Jordan is suggesting some innovative solutions to the critical problem of declining innovation. His committee will report in April.

**Hugh Lavery** retired from International Paper last year. His son Hugh (Course X,1973) is carrying on in the field, however, working toward his doctor's degree at the Institute of Paper Chemistry.

**Vince McKusick**, Chief Justice of the Maine Supreme Court, and his twin brother Victor received honorary degrees from the University of Maine at Portland-Gorham last May.

Air Force Reserve Major General **Vincent Haneman** received his second award of the Legion of Merit, this time for his outstanding service to the U.S. while serving as mobilization assistant to the Commander, Headquarters Air Force Logistics Command, Wright-Patterson A.F.B., Ohio, from 1972 to 1977. He is now mobilization assistant to the Deputy Chief of Staff for Research and Development at the Pentagon.

After graduation from M.I.T., Vincent took an M.S. and Ph.D in aeronautical engineering at the University of Michigan. He is also a graduate of the Air Tactical School, the Air Command and Staff College, and the Industrial College of the Armed Forces. He enlisted in the Army Air Corps in 1943, was commissioned in 1944, and served on active duty until 1960. He received a reserve commission in 1961. His military awards and decorations include the Legion of Merit, the Distinguished Flying Cross (two awards), the Air Medal (eight awards), European and Middle Eastern Campaign Medal with four battle stars, Air Force Commendation Medal, World War II Victory Medal, Armed Forces Reserve Medal (Air Force) with hour glass device, Presidential Unit Citation, National Defense Service Medal, and the Air Force Service Longevity Award (three).

As a civilian, Vincent is Dean, School of Engineering, and professor of aeronautical engineering at Auburn University, Auburn, Fla. He is also a consultant for General Electric, Space Technology Laboratories, Aerojet General, Lockheed, General Dynamics, and Ling-Temco-Vaught.

**Robin Stevenson** has signed up for a chair and joined the gang in THE SEVENTH ROW of 10-250. Robin is with Aerospace Corp., California.

I regret to report the death of **Kenneth Klingensmith** in June. More information when I have it.

**Samuel Waldstein** is one of sixteen scientists and engineers honored by RCA with 1978 David Sarnoff Awards for Outstanding Technical Achievement. He was one of a team of three at Automated Systems in Burlington, Mass., honored "for excellence of team effort in the product development of a hand-held laser rangefinder."

M.I.T. is proud to have alumni constitute 13 per cent of the 200 new 1978 A.A.A.S. Fellows. Our class accounts for 1 per cent all by itself with our new Fellows **James Alan Fay** and **H. William Welch**. **Felix Browder** is also listed. He started with our class, but putting a reverse twist on class switching, wound up with the Class of '46.

Let's hear from YOU! Love, **Ginny Grammer**, Secretary, 62 Sullivan St., Charlestown, Mass. 02129

# 48

**Dick Berry**'s wife, Louise, is the Republican candidate for Connecticut's Secretary of State. Louise has been active in public life for many years, as a state senator and now chairman of the local school board. She's also in her final year of law school. Louise and Dick have three children. Daughter Pam will be getting her S.B. in Course X next spring and son Don is at Yale Law School. Dick is Vice President, Research, Development, and Engineering of Rogers Corp. — manufacturers of products ranging from interconnection devices for electronics to high density polyurethane foams. In his spare time Dick serves as member of Connecticut's State Board of Higher Education.

**John D. C. Little**, Professor of Operations Research and Management at the Sloan School of Management, received the 1978 Charles Coolidge Parlin Award for outstanding contributions to the science of marketing. The Parlin Award is considered the preeminent national honor in the field of marketing. John's work on the development of marketing models includes research on retail store location, advertising budgeting, media selection, and market planning. John is co-founder of Management Decisions Systems, Inc., a consulting firm specializing in marketing models and information systems, and he recently became President-elect of the Operations Research Society of America. Besides marketing, John has been active in other operations research areas including mathematical programming, queuing, traffic signal control, and citizen feedback.

**Bob Stern** and **Ken Wiberg** were recently elected fellows of the A.A.A.S. Of the 200 new fellows 13 per cent are M.I.T. Alumni. Even more dramatic is the number of members in the National Academies for Engineering and for Science — they make up 20 per cent of the combined membership (160 people).

**George Keller**, vice president of Standard Oil of California, has been named to fill a one-year vacancy as vice president of the M.I.T. Alumni Association. . . . **Norm Herbert** sailed his *Albacore* at Cape Canaveral, Key Largo, Tampa Bay, and Cape Henry over the winter and spring. The winds were sometimes stronger than on the Charles but not as variable as the "Institute Wind" that Norm remembers. . . . **Boni Martinez** recently retired from Dupont and became president of Kapejo, Inc. in Wilmington, Del., a distributor of DuPont polyester fiber used as a replacement for asbestos fibers in asphalt curbing. Boni was instrumental in developing the reinforcing fibers while they were experimental products.

**Ellis Barron** died of cancer on May 21, 1978. Ellis and his wife Laurel attended our 25th Re-

union in 1973. . . . **Robert Carbee** died last year. . . . And we have just received word that **Ernest Miklau** and **James Morris** passed away. On behalf of the class I extend our sympathy to the survivors of these classmates.

**John Kaymen** is retiring from U.S. Steel where he was a senior product engineer. He will be doing consulting work for a while. His wife Eunice has been teaching; daughter Amelia is in Rush Medical School; daughter Hallie just graduated and is job hunting in the publishing business; son Stanley is a junior at Hamilton College and will study in Paris for a year. John plans to sail across the Atlantic and tour the Mediterranean and Baltic Seas. He visited the U.S.S.R. earlier this year. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

# 49

Since I missed the deadline for the last issue, we have two issues worth of news notes to cover. First, the plans for our 30th Reunion in 1979 have been established. Mark your calendars. We will begin at M.I.T. on Thursday, June 7, with Tech Night at the Pops, continuing with Technology Day and official class functions (meeting, elections, etc.) on Friday. Then we will depart for Bermuda on Saturday morning where we will stay at the Inverurie Hotel (at the water's edge in Paget) four nights and five days, returning Wednesday afternoon, June 13 (or if you prefer, seven nights and eight days, returning Saturday, June 16). Cars may be parked at M.I.T. without charge during the Bermuda sojourn. Also, dormitory accommodations will be available there over the weekend for classmates who can attend the M.I.T. portion of the reunion but choose not to go to Bermuda. Complete information on our plans, including travel alternatives and costs, will be mailed to classmates in early October. The theme proposed is "The Swinging 40s." Chingueno!

I have a letter from Phyllis Hudson to inform us of the January death of **Thomas Hudson, Jr.**, which was reported in an earlier column. She writes, "Tom was always proud of his association with M.I.T. and we have a son, T. David, graduating there this year." I also have a letter from **Ken Prytherch** who says "Tom Hudson's death was especially poignant to me since we were high school classmates and fraternity brothers at M.I.T." Ken's letter reports on another deceased classmate, **Roland Derby**, as follows: "I never knew Roland at school but our business paths crossed around 1961. My company (G.A.F.) was interested in acquiring Roland's company since it had a special segment of the dyestuff market we were interested in and was one of our largest resale customers at that time. Roland didn't want to sell, although his father, who had started the business, wanted to make the deal. It never came off, however. Until my responsibility changed in 1974 at G.A.F., I was in fairly constant touch with Roland and probably got to know him as well as anybody could. He was an avid duck hunter and since I'm an avid birdwatcher we had some interesting discussions on looking versus shooting. He also flew his own airplane. I believe he got his M.S. in Chemistry at night at Lowell Tech, and I know he earned a Ph.D. at M.I.T. while running the family business. It took him many years to do it and we used to kid him that he was probably the oldest student ever granted a Ph.D. at Tech. He was very interested in color measurement and became a recognized authority in that rather specialized field. He was a brilliant fellow. This is not a happy time to write the class secretary."

On a happier note, we have the following letter from **Robert C. Peterson**: "When I arrived in Iran to take up a new assignment in the Organization and Productivity Division of the Abadan Refinery, I was informed that all jobs were being 'Iranianized' and therefore I should not anticipate staying more than one contract of two years. Now, 16 years later, my job has finally been Iranianized and I am leaving the company on July 1. I can be a gentleman of leisure for a while as my vacation will last until October 15. It has been a long and interesting time here in Iran where I spent six years at the refinery in Abadan, five years in Tehran and then moved to the fields where we have spent three years in the desert city of Ahwaz. My three children (one daughter born in Iran) grew up out here and both boys are now Tech graduates — Jeff a chemical engineer, class of '76, and Andrew in biology, class of '78. He is going to medical school this fall. The next chapter in my career is completely flexible and I may just spend some time painting and playing the cello, both of which have been serious avocations for a number of years. I have played the cello in quartets and other chamber groups in Abadan and Tehran. Ahwaz however is not only in the desert but is a bit of a cultural desert and despite efforts to find fiddlers, the Ahwaz string quartet has had three vacancies since day one. Right now we are rattling around our house as most of the furniture has been sold and we are looking forward to a new chapter in our life after we leave."

Four Alumni Fund notes arrived. **Alan W. Collins** writes "This year included some radical changes for me. I dissolved my marriage of 23 years and quit my job as M.I.S. Director for N.R.M. Corp. I took a couple of months sabbatical to recharge the batteries and chart a new course unencumbered by external pressures. I accepted the position of Director of Central Data Processing for the State of Indiana in Indianapolis. I'm looking forward to some interesting and challenging opportunities (particularly after the passage of Proposition 13 in California). Hope to hear from and see some old M.I.T. friends in or passing through Indianapolis. Cliff, 23, is in electronics with Toledo Scale in Columbus; Pam, 21, has dropped out of school for a while to get her head (and some money) together in Akron; Scott, 18, finished his first year at Akron University and will move with me to Indianapolis and attend Indiana University or Purdue University." **Jack Lake** reports that he is "deeply involved in New York state's rehabilitation of railroads. His son Anthony graduated in 1976 in computer science; son Chris is studying biology at New Paltz and Sally is studying law and music at Sarah Lawrence. When they all finish I'm going to take a long train ride!". . . **Gregory Lynes** has "just accepted a new position with American Institutes for Research, Bedford Systems Division, in Bedford, Mass., as a senior research scientist. I am looking forward to an exciting new challenge centered around human factors engineering and research.". . . Finally, **William F. Wicks** was made Director for Undersea Warfare at E.G.&G. Washington Analytical Services Center, in Rockville, Md. He is living in Reston, Va.

From press releases and news reports, we glean the following on honors and promotions: **John D. Alden** is now Accreditation Director for the Engineer's Council for Professional Development, after 13 years as Manager of Manpower Activities for the Engineers Joint Council and Executive Secretary of the Engineering Manpower Commission. . . . **John M. Cook** has become manager of transportation services for Bethlehem Steel Corp. for whom he has worked since

## Gordon: The Profession Endangered by Softness in the Engineering Schools

American engineering has symptoms of the early stages of a very serious degenerative disease, says Barnard M. Gordon, '48, Chairman and Technical Director of Analogic Corp. "We're in deep, deep trouble," he said as keynoter for Electro '78, the annual convention of the Institute of Electrical and Electronics Engineers in Boston late last spring.

The symptoms as Mr. Gordon sees them:
—Decreasing productivity of new engineering graduates.
—Decreasing appreciation among new (and some older) engineers of the "rigors of invention."
—Decreasing appreciation by engineers of "the joys of accomplishment."
—Inadequate numbers of young people preparing for engineering careers.

The disease is centered in today's engineering schools, says Mr. Gordon; they've grown "soft," content to "pass students through" without turning them into engineers at all.

"I've been horrified by the attitudes of professors in the engineering field," Mr. Gordon told the I.E.E.E. "They're encouraging emphasis on narrow, specialized areas of learning. They're allowing engineers to graduate who are unable to write a single gramatically correct sentence. They're turning out an absence of young technical leaders.

"The average professor in school today hasn't the foggiest idea of what is required of an electronic engineer today. Too many teachers know too little of what engineering is about."

If he's to be successful in the profession, an engineering student should be taught five things, said Mr. Gordon:
—A competitive spirit.
—An understanding of, and ability to identify with, another's needs.
—An understanding of professional goals and responsibilities. "Most graduates believe they should immediately become chief engineers, without having any knowledge of what that entails," said Mr. Gordon.
—A broad training in mathematics, basic physics, and mechanical and electrical principles. "Students should be trained in computer science, for example, not computer usage," he said.
—The ability to communicate fluently, both verbally and in writing.

Though the disease of soft education clearly afflicts universities, the fault and the cure lie in industry's hands. The trouble began, said Mr. Gordon, when industry failed to be demanding and critical enough of engineering schools and their products. "We let them do it. We ignored the symptoms."

His cure is for industry to get tougher — to "force quality control on the universities" by demanding better graduates. Make it harder, not easier, for young people to find engineering jobs, he told his I.E.E.E. colleagues. "The message will get back to the universities" quickly enough, he said.

graduation, most recently as district transportation manager at the Sparrows Point plant in Maryland. . . . **Russell Cox** is a member of the M.I.T. Venture Forum Committee which calls on alumni expertise to offer help to alumni entrepreneurs in diagnosing business problems and advising on steps to take to achieve company goals. (Contact the Forum at M.I.T. for information on this new and novel program.) . . . **Alex D'Arbeloff**, co-founder and president of Teradyne, Inc., and director, trustee or affiliate of Thermo-Electron, Advent Corporation, M.I.T. Task Force, the Y.M.C.A. and the Provident, has been elected a trustee of the New England Conservatory of Music. . . . **Charles K. Holmes**, vice president of Coca Cola U.S.A., has been named to a two-year term as vice president of the M.I.T. Alumni Association. And three classmates have been honored by election to National Academies: **Richard J. Reed** to the National Academy of Sciences; and **George Hatsopoulos** and **Walter Morrow** to the National Academy of Engineering.

**Barbara Feeney Powers** became the only woman public high school principal in Vermont on July 1, when she took over at Champlain Valley Union High School. Since M.I.T., Barbara has received a master's degree from Rockford College in Illinois and a doctorate from the University of Wisconsin, where she also attended law school. She was a teacher in Massachusetts and an assistant principal in Illinois and Wisconsin. . . . **William C. Schneider** has been named N.A.S.A.'s Associate Administrator for Space Tracking and Data Systems and is now responsible for planning, development and operation of global tracking networks, facilities and systems for communication and data acquisition and procession for all N.A.S.A. space flight programs. Bill has an M.S. from the University of Virginia and a doctor of engineering from Catholic University. In N.A.S.A. since 1963, he has had his share of awards: N.A.S.A.'s Exceptional Service Medal for his role as Gemini Mission Director for seven of the ten manned flights; he directed Apollo missions 4 through 8 and received N.A.S.A.'s Distinguished Service Medal for his contribution to the success of Apollo 8, the first flight around the moon. For his role as Director of the Skylab program, he received a second N.A.S.A. D.S.M. and was co-recipient in 1973 with the three Skylab astronaut crews of the Collier Trophy. Whew! Congratulations to all.

On the darker side, inevitably we receive news of more deaths: Commander **Joe W. Thornbury** on June 22, 1976, and **Robert J. Vidal** on May 28, 1978. I have no further information now.

News of publications or speeches for four classmates: **George Hatsopoulos**, a *Harvard Business Review* article on economic barriers to more efficient industrial energy generation and use; **Fletcher Eaton**, the E.S.N.E. President's essage; **Harry Lambe**'s *Chemtech* article, "Plant Cost versus Developing Country Location"; and **Eugene Skolnikoff**'s participation in the Cambridge Forum meeting on "Nuclear Power and Proliferation."

Enough. My hand aches. It is done. My August vacation trip to Brevard, N.C. for a week of square dancing starts tomorrow. Best wishes to all. — **Frank T. Hulswit**, Secretary and 30th Reunion Chairman, 77 Temple Rd., Concord, Mass. 01742

# 50

**Andrew Price** tells us that his youngest child was married in June and he now feels completely retired. He fills his time with golf, travel, philately and cryptanalysis. . . . **Lee H. Powers** spent an interesting year and a half installing tools in an automobile factory in the Ural Mountains of the U.S.S.R. — and while there he married a beautiful young Russian woman. . . . **Dick Bolles**, has a book on the national best-seller list: "What Color Is Your Parachute? A Practical Manual for Job-Hunters and Career-Changers." And Dick has another book just out — "The Three Boxes of Life, and How to Get Out of Them," dedicated to his brother Don Bolles, a reporter who was slain in Arizona two years ago.

*R. Stanley Bair, '50*

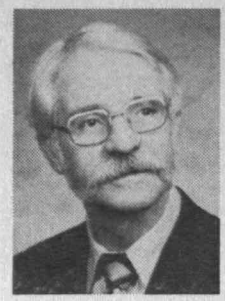
**John H. Litchfield** was among 47 inventors honored recently for patents they received during 1977 at Battelle Memorial Institute's Columbus, Ohio, Laboratories. Dr. Litchfield is manager of the Bioengineering/Health Sciences Section at Battelle as well as adjunct associate professor of nutrition and food management at Ohio State University and a past president of the Society for Industrial Microbiology. He was cited for two patents for the development of a series of compounds which prevent tooth decay by prohibiting lactic acid formation when added to oral health products. . . . **Claude D. Tapley** is presently development engineer at the Anaconda Co., Brass Division, in Waterbury, Conn. . . . **R. Stanley Bair**, of Houston, Tex., has assumed the office of president of the Construction Specifications Institute — a national technical society that serves as a national clearinghouse for architects, engineers, and others whose primary concerns are construction specifications and communications. He joined C.S.I. as a member of the Dallas Chapter in 1959 and transferred to the Houston Chapter in 1967, where he served as a director and as chairman of the Education Committee. He organized and taught the first specification writing course at the University of Houston.

**John H. MacMillan**, Vice President of Babcock and Wilcox's Nuclear Power Generation Division in Lynchburg, has been elected a Fellow of the American Nuclear Society by the Board of Directors of the Society. This honor acknowledges the significance and value of John's accomplishments in the nuclear field; 347 distinguished scientists, educators, and engineers have been awarded this recognition over the past 24 years. He is currently on the A.N.S.'s Board of Directors and is chairman of the Finance Committee. . . . **William H. Enders** has been appointed to the newly-created position of vice president of product planning and development for the G.T.E. Consumer Electronics Group, a part of General Telephone and Electronics Corporation. Bill has worldwide responsibility for directing and coordinating all product development activities for the Group, which designs and manufactures color and black and white television sets and picture tubes and audio products. He will be located at G.T.E. World Headquarters in Stamford. — **J. T. McKenna, Jr.**, Class Secretary, 2 Francis Kelley Road, Bedford, Mass. 01730

# 51

Many thanks for the multitude of notes. I have to admit it is not only more fun but considerably less work when you let us hear from you.

**Maria Bentel** and her husband Frederick are architects living and working together on the farm on Long Island. The Bentels met in school where they were both students of architecture. They won Fulbright Scholarships and married, almost simultaneously, and went off to their respective studies — Frederick in Austria and Maria in Italy. On their return to the United States, their first project together was an addition to a Unitarian Church in Queens. Their projects include the Glen Cove Boy's Club, the Commack Library, the Energy Center for New York Tech, and the Commons at Post, which won the Long Island Association of Commerce and Industry's Gold Archi award.



*Grant Larson, '51*

Also in the field of architectural recognition and honors, during the ceremonies at the C.S.I. Annual Convention in June of this year **Grant Larsen** was named a Fellow of the Construction Specifications Institute for his Achievement in Science of Construction. Grant has been a professional member of the San Francisco chapter of C.S.I. for 20 years serving as chapter Chairman, Director, Vice President and President.

**Bernard Rothzeid** was recently awarded a national A.I.A. Design Award, also an award from *Housing* magazine and a design award from *Urban Design* magazine. . . . Congratulations to **Marvin Grossman** recently named to a two-year term as director of the M.I.T. Alumni Association. Marvin is president of Electronics Marketing, Inc., here in Auburndale, Mass.

Another classmate in the electronic component business, **Morley Kahn**, wrote to tell us that he has recently moved to his new home in Greenwich, Conn., with his wife Yvette and two sons age 12 and 9. Morley is Executive Vice President and principal of Component Marketers, Inc., sales representatives in the metropolitan New York area.

**Herb Voelcker**, professor of electrical engineering at the University of Rochester is also director of the university's Production Automation Project, an applied research group sponsored by the National Science Foundation. The Project recently announced the development of a prototype computer software system that could be the beginning of a new phase of industrial automation. The system involves development of a language that can precisely describe simple mechanical parts and part assemblies. There is also a set of computer programs that understands the language describing these parts and can automatically reproduce engineering drawings.

**Harry Johnson** is currently Professor of Chemistry and Dean of the Graduate Division of the University of California, Riverside. Harry and his wife Margaret are the parents of three girls, 12, 14, and 16. . . . In the Midwest **Ed Martin** reports meeting with **Walter Wells** on a recent business trip to Littleton, Colo. . . . Locally, **Bill Cavanaugh** is currently serving a two year term as President of the National Council of Acoustical Consultants. He had previously served as Director and Vice President.

Happy to hear from two old friends, **Paul Sanders** and **Aaron Brody**. Paul has apparently decided that politics is too important to be left to the politicians and so he got himself elected state representative in Bellvue, Wash. Aaron Brody was recently named Vice President, Public Affairs, and Chairman of the Public Affairs Force of The Packaging Institute. Aaron is the New Ventures Manager for Mead Packaging in Atlanta, Ga., and lives in Dunwoody. He has received several citations for professional accomplishments in the fields of food technology and packaging and is the author of four books including the widely acclaimed *Packaging in Perspective*.

**Al Boltax** has apparently got it all together. He is bald, bearded, divorced and happy. However, he does wonder when the federal government will realize the need to speed up the licensing of water reactors and development of the breeder reactor. He believes the environmentalists are out of their element when they claim they alone have all the answers on energy policy.

Congratulations to **Jim Barnes** and **Judson**

*Aaron Brody, '51*

*Carl Graf, '51*

*Howard Zasloff, '52*

*Charles Ehlers, '52*

*William Hannon, '52*

**French** for their election to Fellows of the I.E.E.E., and to **Dave Ragone** elected Fellow of the A.A.A.S. As a further note, A.A.A.S. elected 200 members to fellowship this year and 13 per cent were M.I.T. alumni.

**A. H. Newcombe** of Wayland, Mass., was recently named International Sales Manager for the Process Equipment Division of Bird Machine Co., in South Walpole, Mass. He has been with Bird since 1960 and is a member of the American Institute of Chemical Engineers and the American Society of Professional Engineers.

**Carl Graf** has been named a sector executive and a member of the Corporate Executive Office of W. R. Grace and Co. His sector will include the industrial chemicals operations; the Automotive Specialties Group; the Cocoa Products Division; and the Research Division. Carl will continue as an Executive Vice President of the corporation. His previous title was Group Executive of the Industrial Chemicals Group.

Sorry to have to report the death of two classmates; **Oscar Falconi** who passed away in April of this year, and **Arthur Blackwell** of Vienna, Va., who died May 11, 1978. Our condolences to their families.

Ohio State University has announced the 1978 Alumni Awards for Distinguished Teaching. Congratulations to **George St. Pierre** who was one of the eight award winners. . . . An interesting program has recently been developed to aid alumni entrepreneurs. The program is called the M.I.T. Venture Forum, and beginning in the Fall, the Forum will offer alumni who have established or are operating on-going businesses the opportunity to obtain advice from alumni experts and others on possible steps to take to achieve their company goals. Among the members of the Forum Committee is **Al Cohen**. Further information on the program is available from the M.I.T. Alumni Office.

Again, many thanks for your verbal contributions. Lets hear from the rest of you. — **Samuel Rubinovitz**, Secretary, 3 Bowsar Rd., Lexington, Mass. 02173

# 52

This month has been a very fruitful one for corporate appointments in our class, and a goodly collection of notes about various class mambers has also arrived. For example, **Richard H. Daly** writes that he is still a member of the Framingham School Committee and a Signal Processing Department Manager at Raytheon. Three of Dick's children are now in college. . . . **Allan B. Tanner** writes that for the past seven years he and his colleagues from the U.S. Geological Survey have been applying sealed germanium detectors to high-resolution gamma-ray spectrometry in boreholes. The method has been successful for *in situ* uranium assay, determination of disequilibrium in the uranium series, and ultimate analysis of coal. . . . Newly certified in allergy and immunology is **Leonard Schwartz**, M.D. Dr. Schwartz, who was an electrical engineer in 1952, is now a resident of Encino, Calif. . . . Captain **Chuck Mathews** has retired from the Navy and accepted employment with Fluor Engineers and Constructors on an assignment to Saudi Arabia. Chuck was recently with Comnavair Pac at the Naval Air Station, North Island, San Diego, Calif.

C-E Lummus has announced the appointment of **Howard B. Zasloff** to the position of Vice President and Manager of the C-E Lummus Technical Center. C-E Lummus, a subsidiary of Combustion Engineering, Inc., is an international design, engineering, and construction firm with headquarters in Bloomfield, N.J. Lummus Technical Center has worldwide responsibility for the conceptual design of process plants, the application of computer control to such plants, and the technical policy for all of the company's operations. Howie has been with C-E Lummus since receiving his S.B. from M.I.T. and an M.S. from Princeton in chemical engineering. Most recently he was Manager of Lummus Technical Center Operations; he has also been Manager of Process Design and Manager of Petrochemicals. Early in his career he spent three and a half years with Lummus Nederland, N.V., in The Hague. Howie is married to an interior designer, has two daughters, and resides in Rockaway, N.J..

**Charles H. Ehlers**, President of the Dewey and Almy Chemical Division of W.R. Grace and Co., is now Corporate Vice President of W. R. Grace. Mr. Ehlers started with Dewey and Almy as a sales engineer in 1954 and has held several management positions including Executive Vice President for the Division's container and chemical specialties operation. Following studies at M.I.T., he completed the Harvard Business School's Advanced Management Program. He's a member of the M.I.T. Alumni Council and a trustee of the Technology Building Corp.

The American Bureau of Shipping, an international ship classification society, announces that **William M. Hannan** has been elected a Vice President: he will be in charge of the Bureau's Technical Division. Formerly Assistant Vice President, Mr. Hannan joined A.B.S. in 1952 as a surveyor in the Hull Technical Division in New York. He served on the A.B.S. technical staff in the United Kingdom from 1959 to 1962, returning to New York as a senior surveyor, and was named Assistant Vice President in 1974. Mr. Hannan is a native of Russellville, Ky., and graduated with a B.S. degree from the United States Merchant Marine Academy in Kings Point, prior to attending M.I.T. Before joining A.B.S., Mr. Hannan received his Master's License and served in various deck officer capacities on vessels of National Bulk Carriers, Inc., and Socony Oil Co. He and his wife reside in Florham Park, N.J., and they have four children.

**Joe F. Moore**, President of Bonner and Moore Associates, Inc., of Houston, an international consulting firm to the petroleum and petrochemical industries, is beginning his term as President of the M.I.T. Alumni Association. A native of Duncan, Okla., Joe Moore was co-founder of Bonner and Moore and since 1956 has directed the organization's consulting activities in refining and petrochemical processing and economics for major petroleum and petrochemical companies. He was elected an M.I.T. Alumni Association Vice President in 1977, was President of the M.I.T. Club of South Texas in 1970-72, and has been a Director since then. . . . **John T. Fitch**, Director of Technology-Based Educational Development and Marketing at the M.I.T. Center for Advanced Engineering Study, has started work as Executive Director of the Association for Media-Based Continuing Education for Engineers (A.M.C.E.E.). John took a year's leave of absence from M.I.T., beginning in July, to do his job at A.M.C.E.E., which is a two-year old consortium of 17 engineering universities, including M.I.T., founded to "increase the national effectiveness in the continuing education of engineers." Its headquarters is in Atlanta on the Georgia Tech campus. . . . **S. John Zuckernick**, formerly Executive Vice President of the Vermont Electric Power Co., Inc., is now President and Chief Operating Officer. Prior to joining Vermont in December, 1977, for 22 years he was with General Public Utilities Service in New Jersey and Pennsylvania, most recently having responsibility for monitoring electric system operations, planning for the corporation's future generation needs, and conducting economic studies. . . . **Joseph Alibrandi**, President of Whittaker Corp., was the subject of a two-page article in *Forbes* Magazine for May 1, 1978. . . . **Peter H. von Hippel**, director of the Institute of Molecular Biology at the University of Oregon, has been elected to the National Academy of Sciences. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif. 94301

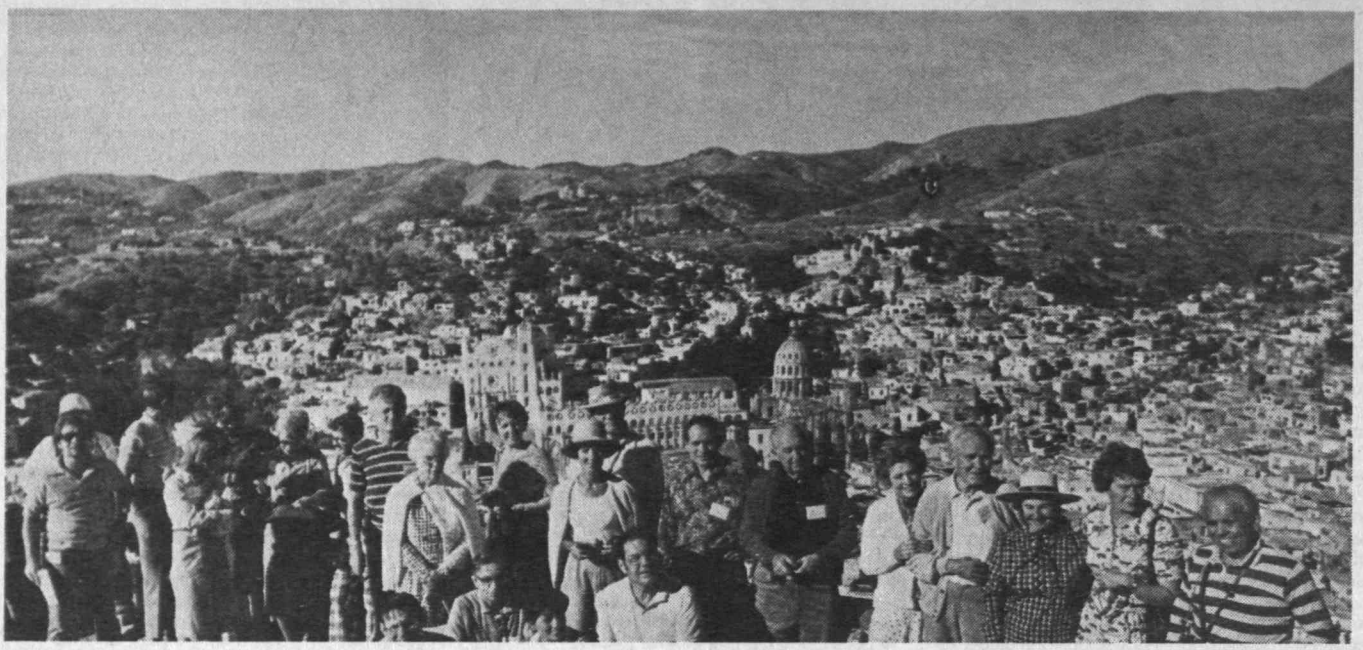
# 54

About five years ago, **George Mealey** and some of his fellow executives purchased the Avco Corp. Electronics Division (their employer at the time), formed Cincinnati Electronics, and started to make a name for themselves in radio and infrared technology. They recently won a competitive contract for "eeavesdropproof," battery powered soldiers' radios, nosing out some of the giants in the communications industry. . . . **Fred West**, who attended the University of Toronto's June Institute of Astrophysics, hopes to get a few spectrograms of double and multiple stars later this year. Fred will be on the faculty of Central Connecticut State through January.

**Stewart Smith** reports that his son David entered M.I.T. as a freshman this fall, which leads me to suggest that many of us will return to the Institute in the spring for our 25th Reunion. . . . **Bob Warshawer** has planned quite a weekend for us all including a complete program for children from six years up. (Make this a "family" reunion.) It will take place June 7-10 and will include Technology Day activities and the following events for the Class of 1954: dessert in the Rotunda of the new Quincy Market after the Pops, a reunion dinner and dance at the Hyatt Regency, a New England clambake, a Boston Harbor boatride, 25th Reunion souvenirs and a special treat from our class vintner, **Mike Sama**. Regional, living group, and activity subchairmen have been hard at work to make this a reunion to remember. — **Dave Howes**, Secretary, Box 66, Carlisle, Mass. 01741; Assistant Secretaries: **Lou Mahoney**, 6 Danby Rd., Stoneham, Mass. 02180, and **Chuck Masison**, 76 Spellman Rd., Westwood, Mass.

# 57

Well, finally some '57 news. I'm sorry for the loss of continuity. I got caught in some interesting politics in my job with the City and resigned in late March. I very quickly got a new job which I really



*" 'Eggheads' in Mexico!" Among those present for the "Fiesta in Guanajuato," the 30th Annual Fiesta of the M.I.T. Club of Mexico City, posed on a lookout with the 16th-century mining town as a backdrop. Nearly 50 alumni and guests from the U.S. joined 30 of their Mexican colleagues for the three-day excursion into the past and present of our southern neighbor nation on March 9-12 — "a few carefree days (for alumni) . . . descending from their intellectual stratospheres," said the* Mexico City News *under the headline reproduced above. Hosts for the event were Raymond H. Dannon, '58, William M. Collins, '65, and Jorge Diaz Padilla, Ph.D. '74, President and Vice Presidents, respectively, of the Club; the official guest of honor was Dr. Carola Eisenberg, Dean for Student Affairs; other special guests included Julius A. Stratton, '23, President Emeritus, and Mrs. Stratton; and Norman B. Leventhal, '38, President of the Alumni Association. Two days earlier Dr. and Mrs. Stratton and other alumni had participated in a tribute to the late Sandoval Vallarta, '21, arranged by the Mexican-North American Cultural Institute in Mexico City.*

*(If you would like to be included in the 31st Annual Fiesta now being planned for March 13-18 in Mexico City and Oaxaca, contact Joe Martori in the M.I.T. Alumni Association.)*

enjoy greatly. More about that next month. Let's first catch up on the mailbag. . . . Here's a letter from **Gil Fryklund**: "I've been sitting around recuperating from a hernia operation, and it occurred to me that if I didn't send you a line now, I'd never get around to it. I've been living quietly in Winchester since 1964 with my wife Gabriele (Drayton). We have two girls (16 and 14) and two boys (8 and 6) — sounds like good "planning" but we cheated by adopting the latest. I did a couple of notable mountaineering ascents in the early 1960s, but have since limited my confrontations with Mother Nature to the technology arena. I started my career with design and analysis of hardware associated with applied physics. When the government research and development money values turned off, I got into precision, large format, graphics plotters and was Computervision's senior mechanical guy for Tycars. I am now a principal in Novatek, Inc., a company that specializes in custom design and fabrication of hardware involving mixed disciplines for various industries, institutions and government agencies."

**Jim Cunningham** dropped us the following note: "We moved to Dallas in November, 1977, and after record snowfalls, we're enjoying a beautiful spring. Although my job as vice president at Docutel Corp. (automated cash dispensers and deautomated tellers) keeps me very busy, I'm becoming involved with the local M.I.T. activities. I'd welcome a call from classmates coming through Dallas." . . . **Silvester Pomponi**, who lives in Bedford, Mass., was awarded the Cross of Aeronautical Merit, First Class, by the Spanish Air Force at a special ceremony at the Air Ministry, Madrid on last October 14. Presentation of the medal, the highest peacetime award of the Spanish Air Force and a rare distinction for foreign civilians, was made by General Alfaro, chief of the Spanish Air Force. The award is in recognition of Silvester's contributions as chief technical advisor on the joint U.S.A.F./Spanish Air Force program which developed an automated air defense system for Spain. Silvester now a technical Department Head for the MITRE Corp., Bedford, led the MITRE technical team which designed the system. The system became operational in September, 1977 and is considered to be the most modern air defense capability presently in existence. A clipping from a New Hampshire paper provides the news that **Charles Mortensen** has been with MPB Corp. in Keene for 18 years. He has taught a technical skills course under the Title A program evenings in Lebanon. He is the current chairman of New London's Budget committee and a Director and Treasurer of King Ridge Ski Area. Two years ago, Charles was the Director and President of the New London Outing Club. The reason for all this being recorded in the paper? Charles was running for a seat on the local schoolboard. . . . A note from **Lee Niemela** reads as follows: "After my S.M. (VI-A) in '58 and my Ph.D. (VIII) in '61, we moved to Geneva, Switzerland, for a year of physics at Cern. I was called to active duty in the Army, landed in the Pentagon, and stayed on as a civilian in the Office of the Secretary of Defense. I ended up as Deputy for Plans and Policy in the Office of Systems Analysis. With the start of the SALT talks in 1969, I moved to the United States Arms Control and Disarmament Agency ending up a Deputy Assistant Director. I have now left the Government to form my own consulting company, the Artemis Corp., specializing in national security and management. Marylyn and I and our two daughters, Julie and Michelle, now live in Potomac, Md."

From **Melvyn Snyder** comes the following news update: "I have joined two other neurosurgeons in private practice in the Torrance-Long Beach area, south of Los Angeles. We have moved to Palos Verdes Peninsula and now have three children — Jason, 5, Kevin, 2, and Laurie, 4 months." . . . **Don Blackford** left his job as Project Manager after nine years for Union Carbide in 1975 to become Process Engineering Manager for Stauffer Chemical. Left Stauffer in 1977 to become Chief Engineer for Rhodia, Inc., American subsidiary of Rhone-Paulenc S.A. He and his wife Evelyn, who comes from the Phillipines, have one child — a daughter, Elaine. . . . **Bill Walsh** advises us that he is still with Mobil but back in International after a stint in Corporate Planning. "I am now Regional Executive for Mobil South with specific responsibilities for New Zealand, Phillipines, Hong Kong, Southeast Asia, etc."

That's all for 30 days — **Frederick L. Morefield**, Secretary, Aquetong Rd., Carversville, Pa. 18913

# 60

Course XVI classmate **Bob Hudock** has rocketed from aeronautics and astronautics to politics. He is the republican candidate for Congress in Pennsylvania's 11th congressional district, opposing incumbent democrat Daniel J. Flood. Bob obtained his law degree at Georgetown University and maintains offices both in Washington and his home town, Hazleton, Penn. He has stayed active in the aerospace comminity, having written over 300 columns for the magazine *Astronauticss and Aeronautics*, and he is interested in scientific policy issues at the national level. . . . Speaking of

Course XVI alumni engaged in national policy, **Vic Utgoff** is director of the National Security Council's Policy Analysis Office. Vic formerly directed C.N.A.'s Naval Warfare Analysis Group; in his current position, he makes recommendations to the President on defense and arms control issues.

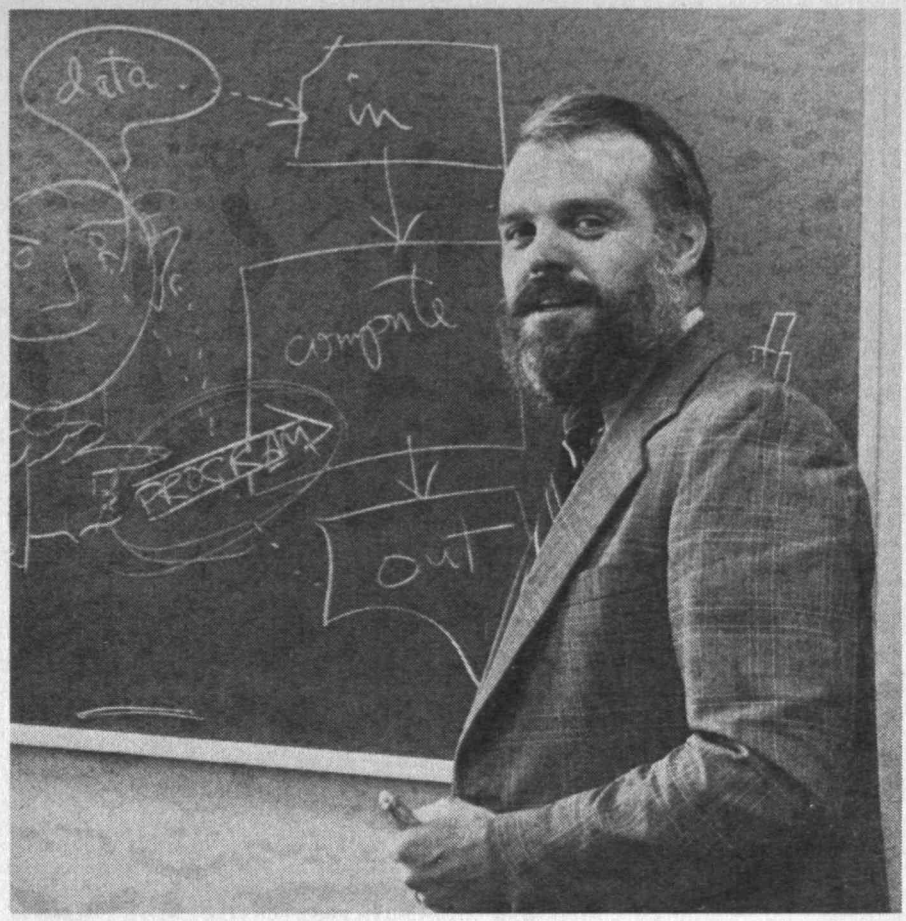
Planning a new venture? M.I.T. has developed an aid to alumni entrepreneurs, and **Sue Schur** is a member of the committee which is making it happen. The M.I.T. Venture Forum offers advice to alumni with businesses at critical development stages. . . . Sue, I may have your first customer. . . . **Sheldon Epstein** writes that he has just received his M.B.A. from the University of Chicago and is striking out on his own to practice law in computer-related areas (using his prior experience as a patent attorney) and to run a computer service business specializing in the repair, modification, and programming of microprocessor-based machines. . . . **Dan Chin** has been named manager of Data General's manufacturing plant in Austin, Tex. Dan will be directing research and development activity for computer terminals at the new facility. . . . **John Maier** is manager of business analysis and controls for the I.B.M. Santa Teresa Laboratory in San Jose. . . . **Larry Brock** has returned to the Draper Lab to work on avionics systems and is living in Lexington.

Larry is a former winner of our Smilin' Jack-of-the-Month Award, which goes this month to **Tom Heinsheimer**. Tom piloted the six-story-high Aerospace Corp. balloon, "America," to a landing in heavy winds in Death Valley following a two-day flight from Rancho Palos Verdes. Tom suffered a hip bruise in the incident, but he emerged from his gondola with data on air pollutants and not, surprisingly, on the performance of the balloon. . . . **Bob McClatchey** also is working on atmospheric problems at the Air Force Geophysics Laboratory, and he received this year's Atmospheric Sciences Award from the American Institute of Aeronautics and Astronautics. Bob heads A.F.G.L.'s infrared physics branch, earned his doctorate in meteorology at U.C.L.A., and lives in Bedford, Mass. . . . **Harold Woolf** was awarded the U.S. Department of Commerce Silver Medal for the development of advanced data processing systems to produce atmospheric temperature soundings from satellites. . . . **Bob Crossley** is serving at the Arnold Air Force Station, where he recently was promoted to lieutenant colonel.

**Walt Niessen**, Vice President of Camp Dresser and McKee, Inc., is back in the news with the publication of his book, *Combustion and Incineration Processes: Applications in Environmental Engineering*. . . . **Bill Bisson** currently is senior architect with Stevens Architects in Portland. In addition to designing and supervising construction projects, Bill is conducting energy audits throughout Maine and New Hampshire, and he has received a Chamber of Commerce award for his efforts to increase public awareness of energy conservation measures. (Our thanks go to an anonymous source in Laconia for this information.)

Two more classmates are engaged in community activities. According to a belated news clipping, **Allan Morgan** was a candidate for the regional school committee in Sudbury this past February, but we have no news of the election's outcome. Allan is with the Cabot Corp., where he is manager of carbon black development. . . . **Barry Karger**, professor of chemistry at Northeastern University, was named to the Academia Team of the Combined Jewish Philanthropies of Greater Boston and Israel Emergency Fund. Barry is director of the Institute of Chemical Analysis, and he recently spent a year teaching at the Weizmann Institute.

**Ronald Rohrer**, professor and chairman of the Department of Electrical Engineering at the University of Maine at Orono, has received the 1978 Frederick Emmons Terman Award "as an outstanding *young* (my italics) educator in his field." This award has special significance to most of us in the Class of 1960 who, contemplating or having recently experienced our 40th birthdays, will find reassurance in Ron's classification, *Passages* notwithstanding. Ron is an author or co-author of three textbooks, and he has received three major awards prior to his current honor.




*Computers are suddenly everywhere, and to Peter G. Anderson, '62, that means that every engineer needs to know how they work and how to program them. But "you don't need to become a 'computer scientist' to apply computer science, any more than you needed to be a 'mathematician' to apply calculus," he writes.*

### Retreading Obsolescent Engineers With Small Doses of Computers

When computer prices started at $50,000, an engineer could be forgiven for continuing business as usual. But today the same computer costs a few hundred dollars, and no engineer who wants to remain competitive can afford to remain aloof.

For most engineers, the most important aspect of what everyone recognizes as a "computer revolution" is barely begun, says Peter G. Anderson, '62, Associate Professor of Computer and Information Science at the New Jersey Institute of Technology. The computers that used to be giants in air conditioned rooms are now small black boxes integrated into such commonplace machines as automobiles, sewing machines, milking machines, typewriters, pinball machines, television sets, and kitchen appliances. And engineers who want to design even the most mundane new devices can no longer ignore the little black boxes and the many advantages they offer.

"Modern engineers, to maintain their competitive edge, have an entirely new component to master," says Dr. Anderson, writing in *RCA Engineer* for April/May, 1978. "To maintain currency, to stave off personal obsolescence, you need to know computer science — how to create and use computer software. It's now as important to your discipline as calculus always has been."

A lost cause for the engineer who went to school in the pre-computer era?

No, writes Dr. Anderson, because the technology of computer programming is not that hard. Instead of *things*, computers process *data*; but there are inputs and outputs just as in any other processes. After a bit of obligatory reading on the subject — with emphasis on "software" — just get into programming with a programmable calculator ($30) and presently with a home hobby computer (less than $1,000); and then start looking for spare time on some nearby commercial minicomputer.

**A Revolution in Stellar Theory from the Beryllium Ratio in Cosmic Rays?**

Small observations sometimes topple big theories, and that may be what's happening in cosmic-ray physics today.

The small observations — reported last spring to the American Physical Society by Andrew Buffington, '61, and several colleagues on the research staff at the University of California's Lawrence Berkeley Laboratory — is this: the two isotopes of beryllium — beryllium-7 and beryllium-9 — occur in high-energy cosmic rays in almost equal quantities.

This modest result (obtained from instruments carried to the edge of the atmosphere by a high-altitude balloon over Aberdeen, S. Dak., on May, 1977) is completely unexpected — and unexplained.

In low-energy cosmic rays, the two isotopes appear in the ratio of about three beryllium-7 to one beryllium-9. On earth, beryllium-7 is found in far smaller amounts than beryllium-9. Nowhere — except in high-energy cosmic rays — are the two found in equal proportions.

It's hypothesized that high-energy cosmic rays — bits of matter which impinge on the earth from outer space, traveling at speeds near that of light — originate in exploding stars. That hypothesis accounts for such cosmic-ray elements as carbon and oxygen: they are created in the hot interiors of stars by the fusion of hydrogen and helium. But no form of beryllium can survive in such a hot environment, so the beryllium in cosmic rays is assumed to result from collisions in space between energetic cosmic-ray particles and free-floating hydrogen atoms. Such collisions would produce beryllium in the three-to-one ratio that is familiar in low-energy cosmic rays.

The different ratio in high-energy cosmic rays suggests that somehow, somewhere in space, some beryllium-7 atoms pick up neutrons to become beryllium-9. Dr. Buffington and his colleagues have only the vaguest notion of how this might happen, and they are speculating that a new model of stellar explosions may have to be devised to accommodate the new data. *J.M.*

**Michael Rosner** has been named Chief of Medicine at Holyoke Hospital. Mike is certified by the American Boards of Internal Medicine and Endocrinology, and he serves on the hospital's committees on medical education, pharmacy, and therapeutics. . . . **David Perry** is assistant clinical professor of psychiatry at the Upstate Medical Center in Syracuse. He is a staff psychiatrist at the V.A. hospital in Syracuse, and he has a private practice as well. . . . **Gordon Mutchler** is keeping busy running experiments at Los Alamos and Argonne Laboratories as a member of the Rice University faculty. . . . **Joseph Goldstein**, professor of metallurgy at Lehigh University, has been named director of the university's electron optical laboratory.

We will wrap up this month's column with the final segment of our lost classmates list: **Stone, Stupplebeen, Swinton, Tolman, Toman, Townsend, Trujillo-Rueda, Upsher, Uy, Wajda, Watanabe, Weiss, Workman, Wright,** and **Wu.** Please write if you have any information on their whereabouts, and while you're at it, give us an update on your own activities. — **Robert F. Stengel**, Secretary, 329 Prospect Ave., Princeton, N.J. 08540

# 62

**William D. Bloebaum, Jr.** has accepted the position of Treasurer for the Industrial Nucleonics Corp., Brussels, Belgium; he will be living in Waterloo, Belgium for one or two years. . . . **Harvey E. Cline** is a metallurgist at General Electric, Schenectady, N.Y. He received a Coolidge Fellowship award for his outstanding achievements in scientific research and engineering. . . . **Leonard M. Goodman** has been a staff member at M.I.T. Lincoln Lab since 1965. He has been nominated as Chairman of the Boston Section Executive Committee. . . . **James S. Madison** has been promoted to Associate Professor, Department of Psychology and Center for Neural Sciences, Brown University. . . . **Henry N. McCarl** was awarded a grant by International Research and Exchanges Board to travel to Bucharest, Romania, and complete his book, "Energy Economics." . . . **John T. M. Pryke** was appointed Manager, New Markets Development, at Compugraphic Corp., a major developer of phototypesetting systems and accessories. **Philip A. Ruziska** was appointed Chief Agricultural Chemical Engineer in the Agricultural Chemical Technology Division of Exxon Chemical Co.; he also serves as Chairman of the Ammonia Safety Committee, American Institute of Chemical Engineers.

**Bardwell C. (Bojey) Salmon** is now Director of Marketing Operations at Honeywell in Waltham, Mass. In April, he was elected to serve on the Wayland School Committee. . . . **Herbert L. Selesnick** has been promoted to Vice President of Harbridge House, a multinational management consulting firm. . . . **George Sinclair** is an A.A.A.S. member; he has been elected to Fellowship as of February 16, 1978. . . . **Joseph F. Vittek, Jr.** is presently on staff at the Flight Transportation Lab, Department of Aeronautics and Astronautics, M.I.T.; he will be conducting a summer program, "Airport Operation and Management." . . . **Raymond P. Wenig** is an active participant in the Association of Minicomputer Users.

Dr. **Carl I. Wunsch** has been elected to the National Academy of Sciences, one of the highest honors awarded an American engineer. . . . **Bostwick F. Wyman** is on leave from Ohio State's math department to teach at the University of Padua (Italy) for six weeks. — **Gerald L. Katell**, Secretary, 7 Silverbit Ln., Rolling Hills Estates, Calif. 90274

# 63

Someone at the reunion likened our five-year pilgrimages back to Cambridge to the journey of the salmon. After a long trip we return to friendly waters to spawn. With only a fast count we could indeed identify three offspring who had been spawned at reunions. While I can't say how much spawning went on at our 15th Reunion, some 35 members of the class of 63 did make it back to the Institute for the festivities. Barbara and I flew into Boston on Thursday, June 8, and settled into our on-campus accommodations at MacGregor House (one of the new West Campus dorms just beyond Burton House). Most of the on-campus dining rooms were already closed and so we asked around — where do M.I.T. men go for dinner these days? For big portions and cheap food that really sticks to your ribs we were told to go to the Rainbow Rib Room on Mass Ave near Boylston. But for a place to go with a date, we were advised to try the Newbury Steak House. Since I did have my date with me, we set off for the old Newbury Steak House, a place pretty much unchanged by the ravages of time. It was a reasonable place to take a date for dinner way back when, and it still is.

After dinner we walked to Symphony Hall, where Tech Nite at the Pops was just breaking up. We ran into Carol and **Pete Van Aken**, Carolyn and **Ira Blumenthal**, and **Frank Model**. We were bused back to campus in time for living group open houses held in several dormitories and fraternity houses. Scouting around Baker, we met some of the present day residents and found their attitudes similar in some ways to what ours were. Some upperclassmen described a winter gag which they perpetrated during a heavy snow storm. Several hundred pounds of snow were brought indoors and placed in an upstairs Baker House bathroom. The students called the Associated Press and reported that M.I.T. students had succeeded in making snow indoors. The reporters were taken in, and the "news" was actually published. This story was recounted as being in the tradition of the great M.I.T. Icicle Caper, which was executed by members of the Class of '63. It was like old times.

We were joined after a while by Pam and **Frank Cocks**. Frank is a professor in the School of Engineering at Duke University. He described a course he had taught last year in using the patent system as a reference source. Pam, who has a Ph.D. in Russian studies, taught me to say "zdrahstvootie" (hello) — definitely a useful word for Barbara's and my upcoming visit to Russia.

Friday morning there were no reunion activities planned. After an early morning jog on Briggs field, Barbara and I attended a *Technology Review* sherry party where we met the *Technology Review* staff and secretaries of other classes. In the afternoon we listened to some of the Technology Day presentations in Kresge Auditorium. The two talks we heard — one on computers and speech and the other on computers, TV, and visual data bases — were very interesting and were indicative of the state of the art in the field of computer science. On Friday evening we had a buffet dinner in the dining room of MacGregor House to kick off the activities planned for our Class. We met and chatted with Esther and **Marty Eisenberg**, **Fred** and **Sandra (Lensch) Cunningham**, Edythe and **Bob Turtz** and Georgie and **Jim Hallock**. . . . I found out that Marion and **Jeff Hogge** are Southern California neighbors of mine. Jeff works at Systems Technology, Inc., and is involved with controls for aircraft and ships. . . . **Ray Solfer** came with his son Donnie. Ray is still a vice president with First National City Bank in New York. . . . We had a long conversation about travel with Yvonne and **Sid Teweles**. Sid taught meteorology for a while in Turkey, and has travelled extensively in Europe and around the world. He classifies cities according to how long it should take a tourist to see a city. Instead of stars the city gets a rating from one to four days. Rome and Istanbul are the only four day cities he has seen.

**Tom Gerrity** dropped in briefly; I also talked with **Ken Overoye**. Ken is working for Honeywell in the Boston area, in the field of electro-optical engineering. As the evening wore on we were talking with **Betty (Hall)** and **Pat O'Neil** when the subject of poker playing came up. Pat, **Frank Model** and I retired to a secluded MacGregor House lounge where we proceeded to explore the fine points of the game.

Saturday began with breakfast in the Burton

House dining room and a discussion of two-career families with M.I.T. Dean of Students Carola Eisenberg, and her husband Leon. Carola is a child psychiatrist by training and Leon is also a psychiatrist. The program was particularly meaningful for Barbara and me since Barbara is Assistant Dean of Students at the University of California in Irvine. About eleven we boarded buses and rode down to Quincy Market (Boston's answer to Ghirardelli Square). Among the group getting this tour of the New Boston were Sandy and **Bob Maskrey**, Frances and **Shoel Cohen**, Linda and **Stephen Markstein**, Lois and **John Flaherty**, and Ellen and **Paul Richman**. Quincy Market has many small shops and flower stalls and is part of a renovation of the area around Faneuil Hall and Durgin Park. The latter, fortunately, is to be left in its original state, but much of the area has changed. We mourned the passing of Scollay Square and the old Howard Theater. Then it was back to campus. Barbara played some tennis with **Jim Evans**, after Jim and Ilse had been jogging together. Walking down Memorial Drive one has a lovely view of the Charles on a summer's afternoon. The Tech dinghies were out in force — white sails on blue water cruising up and down.

That evening we had a dinner and dance in McCormick Hall and transacted our only business — the election of class officers. **Ira Blumenthal** was elected president for the next five years; **Steve Colburn** was elected vice president; yours truly will be secretary again; and **Jack Lynch** was surprised to learn he will be handling our financial affairs. **Tony Doepken** was elected class agent in absentia.

Before dinner I talked with **Lewis Neuman** and met his wife Janet. Lew told me about some old "hacks" he remembered, such as turning on floodlights between the dorms on East Campus at 2 a.m. when a classmate was sneaking out with his date, and wiring the 5th floor light switches to some vintage W.W.II air raid sirens. We had dinner with **Allen Meyer** and his wife, Nancy Russo. We heard about their around-the-world trip — quite an experience. . . . Also at our table were **Martin Schrage** and Joan Archer. Marty had just returned from a European trip as part of his job in international sales for C.S.P.I., a maker of special purpose, high speed computer systems. . . . Also dining and dancing late into the night were Diana and **Larry Erdmann**, Julia and **Bob Johnson**, and **Cynthia Kolb Whitney** and her husband, Dan. After the dance Pete and Carol Van Aken, Ira and Carolyn Blumenthal, Pat and Betty O'Neil, Steve Colburn and his wife, Theo Parker, Marty Schrage and Joan Archer, and the Bertins continued the festivities back at MacGregor House. The late night carousing of the class of '63 awakened the classof '43, who were also quarted in MacGregor. Though we invited them in for a drink, the class of '43 preferred their rest. I wonder if we'll have as much stamina at our thirty-fifth reunion.

Sunday's activities included a swim at the Alumni Pool, and a picnic lunch in the courtyard beside the pool. On the way to the pool we met **Bob Starzec** and his family in the corridors of Building 10. Bob was in Boston on other business, and though he couldn't come to the reunion, he was taking the time to show his family a little of M.I.T. Numerous children were in evidence this morning. Faye and **Dan Ross** had brought the newest addition to their family, an infant son. Their other children had stayed back in Philadelphia, where Dan practices tax law. . . . Margie and **Larry Krakauer** had brought both their daughters. Sara, the youngest, was only three weeks old at the time. . . . I learned that **Jim Champy** married Lois Stern in August. Congratulations to the Champys. . . . Barbara spent some time talking to Anne and **Stu Rooney**. Anne is selling real estate these days. . . . Janis and **Jack Solomon** were in their bathing suits, and swimming too. The Solomons are still living in Rye, N.Y., where Jack works for the Linde Division of Union Carbide. They have a sailboat on the Long Island Sound.

About noon the group started to break up. People began to go their separate ways, and return from the world of nostalgia and reunions to the world of the present. Unlike the salmon, we were swimming again, not to return for five years. I hope my reporting has been accurate and included everyone who attended. My notes are a bit sketchy, and some of this is from memory. If I left something out send me a note and we'll set the record straight. So much for our walk down memory lane. More news next month. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92715

# 64

Greetings '64. Our cups runneth over with class heroes, press releases, lots of those "increased" envelopes (after the gift has been removed, naturally), and a considerable amount of personal news. But first a commercial; Start planning now. We are entering our FIFTEENTH reunion year! It is hard to believe, but in less than nine months, we'll be commemorating and celebrating our class' 15th. Let's try to make this the best one yet, with good attendance and another fun weekend sojourn to wherever (All you budding class secretaries who would like the next five years' action, please apply to the address at the end of this column — your interest will be gratefully noted and raised in the appropriate forum during the reunion!).

Now to our class heroes. First, the most unusual class hero in our class' history, a proud father (Bless him!). Mr F. J. Tuggle wrote us a very nice note to tell us of the achievements of **F. D. (Doug) Tuggle** and family because, as Mr. Tuggle so aptly put it, "I know that my son, . . . will not write to you, so . . . I will write." After graduating from the 'tute in 1964 with a S.B. in industrial management, Doug went on to get his Ph.D. in industrial management at the Carnegie Mellon Institute. He spent ten years as a professor at the University of Kansas, and he has recently been appointed Associate Dean at the Jesse H. James Graduate School of Management, Rice University, Houston, Tex. Congratulations, Doug! On the family side, Doug and Mary Ann (Tredway) were married in 1967, and now they have two daughters, Wendy E. (5 years old) and Laura M. (3 years old). Congratulations again, Doug, and thank you for the information, Mr. Tuggle!

Our second class hero is **Ron Gilman**, who was recently installed as President of the Tennessee Young Lawyers Conference at the 97th Annual Meeting of the Tennessee Bar Association. Ron sent me a news clipping of the announcement and penned in the fact that he just barely made the age cutoff, 36 for the T.Y.L.C. I guess that's happening to all of us these days (I was 36 a few weeks ago). Somehow, 36 no longer seems as old as it did when we were in college. Congratulations to Ron from all of us, and a personal best wishes to you and your family from ours, Ron.

Our third class hero only made class hero status this month because I am late with the class notes as usual. **John Meriwether** has sent me another postcard for my collection. This one captures the beautiful Cinnamon Bay Beach on St. John in the Virgin Islands. John is leaving his island paradise next March to join the staff of the Space Physics Laboratory at the University of Michigan as a research associate professor and, as he so well states it, return to the "northern hinterlands" and the jaws of winter. While in Innsbruck, Austria, John met **Marvin Geller**, a Course XVIII classmate who is now at the University of Miami. So John is a double class hero. Enjoy your last Caribbean winter, John.

Now to the news we have gleaned from those Alumni Fund envelopes. Keep more coming. They help keep MIT going. **Richard Boyd** will be a visiting associate professor in the Department of Linguistics at M.I.T. this fall. At present he teaches philosophy at Cornell University, specializing in the philosophies of science, of the mind and of language. Richard has recently presented a paper on the role of metaphor in scientific theory construction at an interdisciplinary conference at the University of Illinois. By the time this is in print, Richard will be married to Prof. Barbara Koslowski, also from Cornell, in the Department of Developmental Psychology. The Boyds are collectors of 17th- and early-18th-century American country furniture and would be interested in hearing from other collectors.

One of our classmates is off to Athens, Greece, for a three-year assignment. **Leo Cardillo**, his wife and three children are all looking forward to the experience. . . . **Joseph Kirk** is now into consulting after spending four years in various policy positions in government. Joe is a principal at I.C.F., Inc., a policy analysis consulting firm in Washington, D.C. . . . In February **Robert Popadic** was transferred from General Manager of State Street Boston Leasing Co., a subsidiary of State Street Bank, to head of the planning department of the parent company, State Street Boston Corp. In April the Popadics' second child, John Robert, was born.

**James Rome** is still working at Oak Ridge National Lab in the Fusion Energy Division. Jim is primarily doing work on the theory of neutral injection heating of tokamaks. . . . Our class has a movie producer in our midst — **Paul Sapounakis**. . . . **Jay Tenenbaum** is still working in Computer Vision at S.R.I. but now as manager of that research program. His wife Bonnie has her own educational consultant business, and their son Joshua is 6 and entering first grade.

I have the sad duty of reporting the passing of a classmate, **Norman Cohler**, on March 24, 1978. I received no details or other information.

On the personal side, we have had a rather busy but fun-filled summer. The boys, now 6 (Lewis) and soon-to-be 9 (George) went to a nearby day camp, got well tanned, and had plenty of exercise. Marlene has been completing the personalizing of our house, such as painting, wallpapering, carpeting, landscaping, and even considering a porch for the backyard. We have had a steady stream of friends and relatives visiting since Memorial Day.

Recently, we attended a couple of M.I.T. alumni birthday parties, one for **J. Carl Uhrmacher** and one for Don Goldman, '65. Last weekend, in the midst of birthday going, a group of us with children voyaged up to Baltimore Memorial Stadium to see the Orioles play the Yankees. The game went to the Birds, 3-0, called at the end of six innings due to rain, which was extreme good fortune for the O's, as five Yankee runs scored in the top of the seventh were nullified when Baltimore couldn't get its at-bats.

Remember the FIFTEENTH! Write! Ciao! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

# 65

There are lots of Alumni Fund envelopes this time around and even one short letter. You all are doing a good job.

Debra and **David Lerner** have recently moved to Phoenix where David is working for Honeywell and Debra is with Univac. The Lerners have a son, Joshua, age 2. . . . **Ralph Cicerone** is continuing to do research in atmospheric chemistry at the University of Michigan. . . . **Robert Chinchillo** was awarded a Black Belt in karate in June.

After working a year at an Italian satellite launching base in Kenya, **Steve Eberbach** is still living bachelor style in Ann Arbor Michigan. Steve started D.C.M. Corp. which is working on developing better-sounding loud speakers. . . . **John Chiappetta** is living in Houston, working with Randall Corp. in cryogenic gas processing. Before that John worked for Aramco doing a variety of gas and oil work in Houston. He sends his best wishes to 1964 and 1965 class members. . . . **Dan Diamond** recently remarried; Joan is a sculptor and proprietor of the Last Unicorn Co. The Diamonds are living in Harvard, Mass. . . . **Bill Brody** is at Stanford doing research and practice in the departments of radiology and electrical engineering. He and **John Roach** have been running marathons in their spare time. . . . **Po-Chiu Mar** has returned stateside after five years with A.M.F. in Japan. He and wife Christine, son Erik (11) and daughter Pamela (9) are living in Potomac, Md. Po is manager in G.E.'s information

services division.

**Allen Pogeler** moved from Illinois to California where he is managing United Detector Technology in Santa Monica. . . . **Herbert Mower** has left the Boston area to accept a position as radiation physicist with a radiology group in Cape Girardeau, Mo. He is designing a new radiation therapy center at Southeast Hospital. Herb also continues as Renovation Fund Coordinator for Sigma Chi. . . . **Donald Yansen** has recently started a consulting company. The Yansens are still living in Lexington with their daughters, who are now 8 and 5 years old.

**John Holdren** was promoted to a full professor at the University of California at Berkeley this spring. His wife Cheri has passed her candidacy exam for a Ph.D. in biology at Stanford. Their children Craig (11) and Jill (9) are flourishing violinists and backpackers. . . . **David L. Cohn** is Associate Professor of Electrical Engineering at the University of Notre Dame and has recently coauthored two text books on microprocessor systems and decision theory. . . . **Charles (Chico) Gholz** reports that his firm of Kile and Gholz has become associated with Baker and McKenzie, the world's largest law firm. Kile and Gholz, in Washington D.C., will continue to specialize in patent and trademark law. **Ira Turner** is presently on sabbatical leave from Rafael, Israel.

**Richard Armstrong** has been appointed Assistant Director of Admissions at M.I.T. Reverend Armstrong, his wife Pat and their two daughters live on a small farm in Falmouth. . . . **Jack Freed**, who is working at Cornell University, has been awarded a grant from the National Resource for Computation in Chemistry. . . . **Richard Nathan** was recently honored by Battelle Laboratories for patents he received in the field of solar energy. . . . Teaching M.I.T. summer programs this past summer were **Richard Larson**, who taught about operation research in the public sector, and **Amedeo Odoni**, who taught courses on air transportation.

That's it for the fall. — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley Mass. 02181

# 66

A fair amount of news comes through Cambridge this month.

**Tom Gomersal** left the Travelers Insurance Co. and Hartford, Conn., in September of 1977 and began working for the Wyatt Co., a pension consulting firm in Cleveland, Ohio. . . . **George Bourie** is still working for Education Computer Corp. in Strafford, Pa., as an engineer/programmer designing computer-controlled simulators; he is also taking evening courses at Villanova for an M.S. in Computer Science. . . . **Ken Baxter** is manager of the Advanced Digital Development Department (radar and sonar systems) at I.B.M.'s Federal Systems Division's Manhassas, Va., facility. He and his wife Rita and their three children (Tom, 9; Kristina, 4; and Matthew, 1) reside in Warrenton, Va. Ken has been with I.B.M. for 12 years.

For the last two years, **Hal Helfand** "has been working as a contract systems analyst/programmer and enjoying the freedom of being self-employed. I've worked on half a dozen machines from micros to maxis in half a dozen languages and love the variety that a regular job doesn't provide." . . . **Dennis Nagy** is currently assistant professor, Department of Civil Engineering, Princeton University. . . . **Marland Whiteman** married Jeanette Weckerle on January 28, 1978; they presently are living in New York City. . . . **Harry Moser** writes that he currently is manager of special projects at Acme Cleveland Corp. He is also running in A.A.U. 5-mile and 10,000-meter runs — he finished 229th out of 1300 in the recent Revco-Cleveland run.

**Dave Liroff** is now director of broadcasting at P.B.S.'s member station *KETC-TV 9* in St. Louis where the station audience has doubled in the last 14 months. He has become increasingly involved in national public television activities as a member of the network's Program Managers Advisory Committee. . . . This summer **Jim Sweeney**, Associate Professor, Stanford University Engineering-Economic Systems Department, will become executive director of the Energy Modeling Forum, a national activity based at Stanford with a goal of improving the use and usefulness of energy models for policy and analysis. . . . **Mark Yogman** writes that he is product manager for urethane elastomers at Mobay Chemical, Pittsburgh, since January 1, 1978. . . . **Rick Willians** writes that he is doing his own enlightenment training in Honolulu: "Sex and music. Great fun!"

**Jon Burkhardt**, one of the co-founders of Econometrics Incorporated, writes about the company's first three years with satisfaction. The company now boasts almost $500,000 in annual sales, and clients include the Commonwealth of Massachusetts, U.S.D.O.T., H.E.W., and E.P.A. Specialties include transportation and problems of the elderly. . . . **George Leslie** was recently promoted to division manager at the Variable Speech Control Co. in San Francisco. The company is actively licensing a new technology known as V.S.C. to interested audio manufacturers. The patented system allows playback of voice recordings at high speed (for "speed listening") or slow speeds (for transcribing) — with no pitch distortion. After eight years in Japan, George, his wife Yaeko and their two children thoroughly enjoy being "back in the U.S.A." . . . **Bill Del Hagen** writes that "after nine years with Rockwell International as an aeronautical engineer, I have become a trial lawyer with the firm of Kietland and Paskard. I specialize in aviation litigation and product liability defense. A technical education has proved invaluable in this field; M.I.T. should start a law school."

Two M.I.T. Summer Programs are being directed by members of the class; the Computer-Based Information Systems Technology-Database Systems, Telecommunications, and Performance Evaluation program is under the direction of **Stu Madnick**; the Computer Graphics program is under the direction of **Nick Negroponte**. . . . **Henry Schaefer** is an associate professor in the Department of Chemistry and Materials and Molecular Research Division at the Lawrence Berkeley Laboratory, where he is interested in quantum mechanical studies of the electronic structure of atoms and molecules. . . . Pitney Bowes Co. of Stamford, Conn. announced that **Dave Ljungquist** of Redding has been named manager of marketing research. He joined the business systems and equipment company in 1976 as a product planner.

**Bernard Biales** and five other members of the M.I.T. Rocket Society have been named to the nine member United States Space Model Team, scheduled to compete at the World Championships starting September 1 in Bulgaria. . . . Finally, **Terry May** writes, "Since January I have been the chief administrative and financial officer of Astra Image Corp. Astra does special visual effects for *TV* commercials. Currently we are doing special effects for the upcoming feature movie "Star Trek." My wife Melanie is a director at the Strategic Planning division of Mattel, Inc. (I believe she is the highest woman executive at the company). My two boys are 4 and 2 and doing quite well." . . . Keep the cards and letters coming. — **Paul Rudovsky**, Class Secretary, 340 East 64 St., New York, N.Y. 10021

# 67

**Don Davis** was recently promoted to Associate Professor of Mathematics at Lehigh University; his field of research is algebraic topology. He has run several marathons with a best time of 3:03 and hopes to do three minutes better next time, in order to qualify for the 1979 Boston Marathon. He and his wife Jeannie, Boston College '68, have one child, Joelle, age 7. . . . **Steve Marcus** is still doing business litigation as a partner in the Los Angeles law firm of Freenberg, Bernhard, Weill and Karma. He, Carol, and their three children live in Van Nuys. . . . **Al Falco** is designing the blade structure for a 300-foot-diameter windmill for Boeing Engineering Co. . . . Jan and **Dave Sanders** and their two-year-old John are still living in Los Gatos, Calif. Dave is product marketing manager for Hewlett-Packard's Computer Systems Group. . . . **Steve Rife** has departed the ups and downs of Eastern Airlines to become a systems engineer with Frontier Airlines in Denver. . . . **Bob Hodges** is a systems engineer for Scott Paper Co. in Everett, Wash. His favorite toys are his three children, and a fourth is on the way.

Futurist **Harry Pellow** reports that he got married New Year's Eve 1978, and is working on breeder reactor development for General Electric in San Jose, Calif. . . . Anne and **Al Hausrath** have a daughter, Elisabeth McIntyre, born May 9, 1977. Al has been promoted to Associate Professor of Mathematics at the University of Pittsburgh. They will be living in Merida, Venezuela, next year while Al teaches at Universidad de los Andes. . . . **Mel Snyder** is in private practice in neurosurgery in the South Bay Area of Los Angeles and is a clinical instructor in neurosurgery at U.C.L.A. Janice is finishing a Ph.D. in counseling education at U.S.C.

**Mike Scott** writes: "In August, 1977, I was named Executive Director of the Center for Computer/Law in Los Angeles and Editor-in-Chief of *Computer/Law Journal*, a quarterly publication devoted to articles on the computer and law interface. I have also been teaching computer law in a local law school and am writing a text in the field. On the home front, I have recently rejoined the ranks of the unmarried. It seems to be the trend, especially in sunny California, and I am greatly enjoying my newly-found bachelorhood." . . . **Dan Drucker** is an Assistant Professor of Mathematics at Wayne State University in Detroit and lives in Royal Oak with his wife Sue and their three-year-old Joshua. . . . **Carleton Bryant**, program manager for the past nine years of the guided missile frigate program at Bath Iron Works, has been awarded a scholarship for the 1978-79 academic year by the Society of Naval Architects and Marine Engineers in New York and is studying business administration at Harvard Business School. . . . Rumor has it that **Spence Sherman** is alive and well but has no forwarding address. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

# 69

All right sports fans, here's the "latest" with apologies for not supplying the "latest" in several recent *Technology Reviews*.

"It's a Girl!" named Lori Renee, born to Sheila and **Farrel Powsner** on March 13, 1978, at 8:03 p.m. in, or about Brooklyn, N.Y. Congratulations. . . . **Mike Laird** has joined McKinsey and Company as a consultant. Mike expects to move into a home in Pelham Manor, N.Y. soon and thinks it will be a welcome change after six years in Indiana, four of which were spent on a farm.

**Scott Rhodes** along with his wife Jeany and children Jamie and Carrie have been in Italy for almost two years. Scott, of M.I.T. hockey team fame, now roams the ice in a Turin league whenever he takes a break from trying to achieve maximum effiency in the Fiat central spare parts warehouse. The Rhodes have roamed European roads (sorry about that) on vacations stretching from Germany to Hungary to Sicily to France (not necessarily all at one time.) As far as the important things in life are concerned (and what could be more important than hockey) the Italians apparently have several ideas which might be useful if adopted by the M.I.T. Athletic Department and the Boston Metro rinks (ice time and sticks are free).

**Mike Neschleba**, also a hockey star if memory serves correctly, wrote that his family now includes a son and daughter, that Mike has completed his eighth year of R.O.T.C. commitment after reaching the rank of captain, and is now a civilian. . . . **Doug O. Frost** and his wife Wendy have been in Lausanne, Switzerland, since Doug finished his Ph.D. in Psychology at M.I.T. in September, 1975. Doug is researching in neuroscience and Wendy is chief of physical therapy at a university hospital. They "are seeking the meaning of

life, traveling, skiing, and mountain climbing."

**Francisco F. Coronel** has successfully defended his doctoral dissertation in marketing at Purdue. He is now an assistant professor at the University of Cincinnati and is a consultant to Burke Marketing Research. Well done. . . . **Stephen Lee** has been working at S.C.I. in Palo Alto, Calif., for the last three years in energy and power systems related projects. . . . **Peter N. Zacharias** and his wife Kristen announce the birth of a son, Peter Kraft.

**Rudy G. Aeder** and his wife Kathy are living in Westford, Mass., with their four children: Karl, 5; Sean, 4; Glenn, 2; and Katherine, 9 months. Rudy is working for Raytheon Missile Systems. . . . **Hank Levine** and wife Jodi have finally completed training and "at last" are "going to have real jobs!" Jodi will be Associate Director of the Eastern Oklahoma Perinatal Center at Tulsa. Hank will be entering pediatric practice.

**Barry Unger** and Raymond Kurzweil, '70, have developed a machine which converts printed materials into spoken English at 150 words per minute. The device is intended for use by the blind. After congressional testimony on the Kurzweil Reading Machine, by Barry and Raymond, the co-founders of Kurzweil Computer Products, the U.S. Office of Education's Bureau of Education for the Handicapped announced a $1,353,000 program intended to place 30 of the machines in schools in 1978. . . . **Ed Jernigan** has been with the Department of Systems Design at the University of Waterloo since August, 1976. He has been teaching and doing research in pattern recognition. His wife Kim is in a graduate program in English. The Jernigans are enjoying, at the appropriate seasons, cross-country skiing and canoeing.

**Shelley Fleet** and her husband Ed announce the birth of Bradley Spencer Ackerman on Feb. 2, 1978. The Ackermans are returning to Boston to finish their medical residencies. Shelley's newest interest is obstetrical anesthesia. She has seen **Sharon Grundfest** and Morris Kinast, '70, who also are training in Cleveland. Shelley's looking forward to the class' tenth reunion. . . . **Bill Stewart** spent the last two years completing his Ph.D. in industrial and systems engineering at Ohio State University. Bill's wife Jennifer recently received her M.A. in romance languages at O.S.U. In 1978-79 Bill will be an assistant professor in industrial engineering at Purdue.

**Carolyn S. Scott**'s entire note is: "In addition to vegetables and eggs, we raised our own beef this year. It was so easy, we may go into the business as a small-scale adventure." . . . **Hal R. Varian** has accepted a new position as a full professor of economics at the University of Michigan beginning in September, 1977. He married Norma Nemethon on May 11, 1977; and in June 1978, his book *Microeconomic Analysis*, was published. . . . **Joseph A. Horton** completed a fellowship in neuroradiology in June, 1978. He has entered the American Society for Neuroradiology and won its 1978 Cornelius Dyke memorial award for research in image processing of computerized axial tomographic scans. Joseph's work is to be incorporated in Ken Preston's book on non-invasive bio-medical imaging.

Carl Jones, '66, and **Lenore Haas Jones** write that their son Matthew was one year old on February 17, 1978. Carl is working in the Applications Systems Department for Tymshare at the corporate headquarters in Cleveland. Lenore is working halftime on a N.A.S.A./Ames wind tunnel project. Dan Dedrick, '66, and **Carolyn Gissen Dedrick** visited in April with their son Benjamin. The Dedricks are doctors at Mass. General in Boston. . . . **Tim Casady** has been working as a surgical technician for the last four years, operating an ultrasonic generator used in eye surgery.

**Daniel Benn** is working for Digital Equipment Corp. in Montreal. He is still single and is looking forward to hearing from old friends. . . . **John R. Smith** received his M.B.A. and now intends to relax and work on his tennis game. He is at Hughes, concentrating on microprocessor applications. He has just purchased a home in San Clemente (3488 Paseo Flamenco, Calif. 92672) at the opposite end of town from the estate of an unindicted co-conspirator who resigned a high government position just over four years age. . . . **Al Davis** and Jan spent four months in Siberia last winter representing N.A.S. at the Novisibirsk Computing Center. Al joined the Computer Science faculty at the University of Utah in September. His ski instructor avocation continues.

**Alan S. Willsky**, Associate Professor of Electrical Engineering and Computer Science and Assistant Director of the Electronic Systems Laboratory at M.I.T., participated in teaching a course this summer in Modern Control Theory at M.I.T. . . . **Tom Imrich** is with the F.A.A. H.Q. in Washington in the Air Carrier Division, Flight Standards Service section. He is working as an Air Carrier Operations Inspector on the Flight Technical Programs Staff. He completed captain and flight engineer qualifications on the F.A.A. Boeing 707/720 in Oklahoma City. He was a member of the U.S. delegation to the International Civil Aviation Organization conference in Montreal for the first Operations Panel Meeting.

**Jeff Gishen** received a doctorate in computer science from the University of Maryland. He works in an I.B.M. software technology group in Bethseda, Md. He and his wife Linda ski as often as possible although they report limited opportunities after moving to Maryland. . . . **Michael E. Solin** is practicing family medicine (apparently somewhere in Northern Virginia judging by the postmark on his card). . . . **David H. Hunt** received an M.B.A. from the University of Pittsburgh in December, 1977.

**Robert J. Harrington** and wife Cynthia report the birth of a daughter Meredith on Jan. 16, 1978. Bob is market manager with Logisticon in Sunnyvale. . . . **Ron Skellenger** is working with an emergency housing program and will be glad to hear from Sig Eps at P.O.B. 1344, San Rafael, Calif. 94902. . . . **Paul E. Kudirka** passed the Massachusetts Bar exam administered in February 1978. He is now a member of the N.J. and Mass. bars.

**Rick Dorman** was recently promoted to Assistant Vice President in Marketing at Progress Casualty Insurance in Cleveland. He is responsible for all recreational products. Rick and wife Evie are enjoying their daughter Robin and plan a move to a new home in the near future. . . . **Bruce Anderson** is a founder of Total Environmental Action and lectured on the subject of solar home design at Keene (N.H.) State College on Sun Day, 1978. . . . **Robert McGregor**, living in Sharon, Mass., had the lead role in the Neponset Choral Society's production of "The Mikado" at the Sharon High School. From 1971-1975, Bob was manager of musical event for the Armed Forces in Europe.

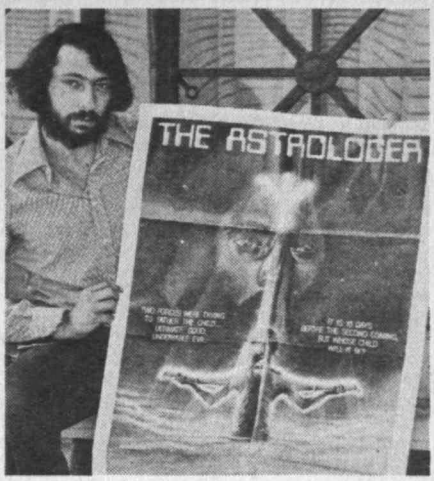
**Richard Wolfson** is an Assistant Professor of Physics at Middlebury College. He received his Ph.D. in physics and astronomy from Dartmouth in 1976. . . . **Christopher R. Ryan** is part owner of Pittsburgh-based Engineered Construction International, a nation-wide specialty foundation contractor. . . . **Donald Collins** is a resident in Gynecology and Obstetrics at the University of Wisconsin in Madison

Mr. and Mrs. **Carl R. Bozzuto** announce the birth of their son Christopher Daniel. . . . **Richard A. Pinnock** received his M.B.A. from the University of Chicago on September 1. Later that month he will commence work in car product planning at Ford Motor Co. in Dearborn, Mich. . . . **Melvyn P. Basan** is working for the N.L.R.B. in Chicago. He obtained his pilot's license in January 1978.

**Robert A. Berntson** has passed the nine year mark with I.B.M. Canada, currently as a manager involved in planning internal administrative systems. His wife Laura has been a general practitioner at a large Toronto clinic for three years. Together they enjoy watching their daughter Andrea develop her own personality. . . . Dr. **Stephen L. Weinberg** issued a press release calling attention to his accomplishments. Steve has coined a new word "Artscience" which the press release failed to define.

**James R. Yankaskas**, M.D., wrote to advise that he received his M.D. from the University of Connecticut in May, 1978, and will be starting his residency in Internal Medicine at the University of North Carolina, Chapel Hill. His wife Bonnie (Simmons, 1967) will be a Ph.D. candidate at the U.N.C. School of Public Health. The Yankaskas' second daughter, Lynda, was born October 5, 1977. Double congratulations to Bonnie and Jim.

It is with deep sadness that I report the death of **Dino A Egidio** in April 1978. Dino received his degree in Aeronautical and Astronautical Engineering and had been with the Aircraft Engine Division of G.E. in Lynn, Mass., since 1973. He served with the Army in Korea during the Vietnam crisis. Dino is survived by his parents, two sisters, and a brother. — **Peter Peckarsky**, Secretary, 950 25th St., N.W., Washington, D.C. 20037




*Mark Buntzman, '71, has turned his knowledge of physics and his interest in science fiction to a logical and potentially lucrative purpose: his first commercial, feature-length science fiction film, "The Astrologer," opened last summer in selected test markets. Mr. Buntzman is the star as well as the producer, and his poster hints at a bizarre plot drawn from the novel by John Cameron: "Two forces were trying to father the child — ultimate good and undeniable evil. . . . It is ten days before the second coming. But whose child will it be?" (Photo: Calvin Campbell)*

# 70

If your bicycle has been stolen — see **Ray Seakan**. His bicycle lock, Citadel, has been marketed through his company in Stoughton since 1973 and has recently been selling quite well. Ray guarantees that his lock will not fail, thus leaving your pedals protected. . . . **Joan Etzweiler** finished her Ph.D. in nuclear engineering and is employed in nuclear safety and licensing at American Electric Power Service Corp. in New York. Her husband is an assistant professor at Columbia in the nuclear field.

**Reid Ashe** edits the *Jackson Sun* newspaper in Jackson, Tenn. He has finished a management development program at Harvard Business School. . . . The M.I.T. Venture Forum Committee with **Aaron Kleiner** is developing a program to commence this Fall to aid alumni entrepreneurs. . . . Technology for the handicapped — read "he Kurzweil Report" issued by **Ray Kurzweil**. . . . The U.S.A.F. behind him, **Marc Weinberg** is now working at Draper Labs. He writes that he enjoys his family, printing photos and bicycle riding. . . . The **Vegeler**s have spent a quiet summer with just regional vacation travel. — **Robert Vegeler**, Secre-

tary, Kennerk, Dumas, Burke and Backs, 2120 Fort Wayne National Bank Bldg., Fort Wayne, Ind. 46802

# 71

**Leonard H. Tower, Jr.** is in Boston, helping out at *The Tech*, working as a printer and bookkeeper. . . . **Arthur M. Gershkoff** finished Yale Medical School and is interning at Roger Williams General Hospital in Providence. . . . Dr. **Thomas E. Finger** writes of three new things: new house, new job as assistant professor in the department of art at the University of Colorado Medical School in Denver, new baby born June 1 named Katherine. Congratulations.

**Jay Mackro** received an M.B.A. from Stanford Business School and is in the manufacturing group at Tandem Computers, Inc. in Cupertino, Calif., producing fault tolerant computer systems. . . . Dr. **Louise Grochow** has completed her senior residency in medicine at the University of Chicago and will be a clinical associate in pharmacological oncology (cancer chemotherapy) at Johns Hopkins Cancer Research Institute. Jerry, '68, is transferring back to A.M.S. headquarters in D.C. to follow her. . . . **Larry Rosenblum** recently received his M.B.A. at Berkeley and is now an accounting systems analyst at Hewlett-Packard.

**Clifton K. Chang**, real estate financier and warehouse developer, is moving to Newport Beach in Orange County to continue developing real estate with the Trammell Crow Co. . . . **Mark D. Horowitz** is an actuarial systems analyst, singing bass in a community chorus, making cabinets and starting evening division law school at DePaul University in September. . . . **Susan Brindamour Fleming** and **Robert A. Fleming** write: "Susan got her M.D. at U.C.S.D. Medical School and is now in her third year of surgical residency at Kaiser Hospital in Oakland. Bob designed biomedical equipment for four years in San Diego and is now a Ph.D. student at Stanford (in electrical engineering, integrated circuit lab) doing acoustic imaging work.

*Martin Tyson, '71*

**Martin Tyson** is head of the system support section of the computer services division for Burroughs Wellcome Co., a worldwide organization of privately held pharmaceutical, veterinary and chemical companies whose distributable profits, after taxes, are devoted to research in medicine and allied fields.

I recently moved my house seven miles out of town. It was cut in two pieces and the roof was removed for the move. It is now together and expected to be completely renovated by Christmas. Please write and tell me of your adventures. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Tex. 77833

# 72

**Sue Leibenhaut** moved this spring to Bethesda, Md., to finish her training in internal medicine. Well, the life of a doctor can't be all that bad since she also managed a trip to the Grand Canyon, as well as time for running occasionally.

This is the graduation season. **Chip Gronauer** got his master's in architecture from the University of Florida. . . . **Gary Chirlin** got another M.S. while enroute to his Ph.D. in the water resources program at Princeton. He decided to return to school after three years with the Smithsonian's Chesapeake Bay Center for Environmental Studies. He also reports that he "married a Simmons (of course) nurse ("in case"), Kristi Johnson three years ago, but has been in good health." . . . **Bruce Schwartz** got his M.C.P. and J.D. "after five years of meandering through the halls of higher higher education." Now that Rutgers has released him he is continuing in his role as a bureaucrat with the N.J. Department of Environmental Protection while he awaits his bar results.) I know that that is no fun.) . . . He also reports that **Bob Fourer** came to the "big apple" to deliver a paper. He skipped a trip to scenic Camden before returning to Stanford.

Congrats to **Eve Sprunt**. She and husband Hugh had their first child, Alexander, on September 10, 1977. Thirteen days later she returned to work, with him, as a research associate in geophysics at Stanford. Now that he is older and more active he only goes to work about 60 per cent of the time. . . . **Richard Abell** and his wife Maryellen are celebrating their first, Maureen, born March 11, 1978. . . . **Richard Braun** and Eileen are celebrating their first, Stephanie Lynn, born April 18, 1978. He is a research chemist for U.O.P., Inc., working on oil refinery heat transfer problems.

**Craig Melin** was recently promoted to Assistant Director of Boston's Beth Israel Hospital. He is in charge of patient support systems. . . . **Andrew Lazarewicz** reports that he and his wife Eva last came to the mainland for his brother **Matt**'s wedding in Cooperstown. Matt is now back at the Sloan School working on his M.B.A.

**Chuck Hafemann** is Director of marketing services for Adage, Inc., in Boston. . . . After three years of working on rewriting the federal bankruptcy laws for the House Judiciary Committee, **Richard Levin** has moved to Los Angeles to practice with a bankruptcy/insolvency firm. . . . After finishing at Sloan a year ago, **Simon Wieczner** accepted a marketing manager position with A.D.P. First Data in Waltham, Mass. (a computer time-sharing firm). . . . **Alan Morrow** is now in Corning, N.Y., working on optical waveguides for Corning Glass Works. . . . **Robert Goodof** reports, "Thank God I travel." He is living in Midland, Mich., working as a project manager of proprietary Dow technology (who else?). He has found the work in plastics fabrication fascinating because he is able to combine the business and the technical end of things.

**Michael Kotch** has been doing the "Cook's tour of engineering over the past three years." He is currently working on an N.S.F. evaluation of the use of the Glomar Explorer for drilling in 12,000-ft. water. Previously he has worked on the space shuttle, laser fusion, offshore drilling, the B-1 bomber, Alaska pipeline and nuclear reactor components. He is also reacquainting himself with life as a single person. . . . **Emanuel Goldman** also became single again in 1975. He's "still unattached, but optimistic" and busy with his hobbies of being a film critic, editor, author and cocktail lounge player. He is an assistant research professor at the University of California, Irvine, and a Lierre Senior Fellow of the American Cancer Society.

*thursday*, or at least its former editor **Tim Kiorpes**, has joined the establishment, having successfully defended his thesis. His old rag described in great detail his sartorial splendor on the big day but neglected to mention in what area he got his degree. . . . **Paul Levy** has been promoted again; he is now Chairman of the Department of Public Utilities in Massachusetts. He is moving up fast, since he only became a Commissioner last January. . . . **Ronald Leemhuis** received his M.D. from the Pennsylvania State University College of Medicine. His school reports that he intends to go into family practice at the Hamot Medical Center in Erie, Penn. It did not indicate whether this is a residency or if he is starting his practice.

That's all the news for this month. Hope to hear from more of you this fall. For myself, the big news is that I've finally joined the "landed class"; I've just closed on the apartment I bought here in the "big apple." Life is currently in an uproar as I am packing for the move, but by the time you read this I will be settled into my place. Send all your news to me there at — **Wendy Erb**, Co-Secretary, The Rivercross, Apt. N714, 531 North Main St., Roosevelt Island, New York, N.Y. 10044

# 73

Hello! Copious news greets the '73er who'd fain gaze upon this cheery corner. **Bob Thomas** reports "lots of changes." To wit; marriage, a new apartment, and a new job, this one with *The Washington Post* as a cost-system developer. Bob is also vice president with a Baltimore-based property management firm. . . . **Don Garvett**'s wife Myra (B.U., '74) has given him child #1, a son Jeffrey Hamilton ('98), on February 9, 1978. Don left D.C. after four years with MITRE to be Director of Planning at Air Florida and live in sunny Miami. (Aside to Don — yes, I do edit letters.) . . . A letter from **Curt Covey** talks of a shift to the Earth and Space Sciences Department of U.C.L.A. Curt received his master's in biology and physics, and will try to earn a Ph.D. in geophysics before retiring.

**Mike Wargo** joined three Tech brothers to surprise their folks at a party in their honor in their native Pittsburgh, Penn., courtesy of M.I.T.'s beneficent and thoughtful Alumni Association. . . . Captain **Scott Berg**'s Air Force unit was the recipient of the Air Force's Outstanding Unit award. Scott is stationed at Blytheville (Ark.) A.F.B.

My old friend and brother Phi Delt Dick Wilson was though to marry a '73er and move to my old home town, so he gets mentioned here. His wife, **Karen Giroux Wilson** is currently a grad student in the entomology department at N.C. State studying the ecology of agricultural insects there. . . . Another old bro', **Jim Silverman**, is an attorney-advisor in the office of Toxic Substances of E.P.A. in D. C. . . . **Mike Scott** is at H-P still, but is now a Marketing Product Manager in the Data Systems Div. in California. Mike also passes on the sad news of the passing of Mark Hannig ('75) in an air crash.

**Matt Kaufmann** finished up at Wisconsin (though he doesn't say in what), married his childhood sweetheart and shifted to a math prof's job at Purdue. . . . **Tom Stagliano** captained a 'tute soccer team to an undefeated season. Tom is at an Aero lab here, and helping the M.I.T. Athletics program to his best efforts. . . . **Richard** ("don't hurt me, big fella") **Galik** has been working almost a year at Penn post-doccing in neutrino physics. Rich married on May 14th, with old roomie Mark Webster ('74) as best man.

**Lenard Yen** shared in the 26th Annual BMI awards for composition. Len's piece was entitled "Split Ends" for string orchestra. . . . **Dan Leemon** joined the San Francisco office of the Boston Consulting Group after over two years in Los Angeles. . . . **Dennis Wantzelius** and **Jim Foran** are working on computerized tomography at Varian Associates of Palo Alto. . . . **Louis Stuhl** married Sheila Kojm (Cornell '73) and moved to Calif., where he is studying homogeneous catalysis at Berkeley. . . . **Sylvia Weatherford** is at Xerox as a semiconductor CMOS components engineer in El Segundo, Calif., after teaching a few years at Howard University in Washington. . . . **Irv** and **Jean Paskowitz** are now entrenched in the M.I.T. Club of St. Louis, with Jean as president and Irv as governor.

**Tony Scandora** pops up in the news this month. His celebrity is attributed only to the fact that I ended up last week visiting my old friend in Chicago while on business. Tony is with SAI, Inc., and working at the Argonne National Laboratories. Tony has just purchased a home in Wheaton, Ill., and lives there with six brooding, breeding hamsters . . . oops, make that ten!

Yours tiredfingeredly, after typing all this, is now a systems representative with old Burroughs, which my salary tells me is one step on the road up to office scut clerk. Go, Sox! — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

# 75

Ah! Another bounty of news has arrived! Here goes: **Paul R. Giguere** is still living in Walnut Creek, Calif., and working for Water Resources Engineers. He was recently promoted to associate engineer and director of computer sciences for the company. Congratulations to Paul as well as to **Bob Rosenschein** who has something a little different to celebrate. He and his wife Diane had their first child, a boy, on May 12, 1978. His name is Avi. Also, Bob is now working in minicomputer systems software for a consulting firm in Arlington, Va. . . . Since graduation, **Michael A Gipe** has been working at GenRad, Inc., in Concord, Mass., applying microprocessor technology to electronics measurements. . . . **Marylee W. Hull** is an associate production engineer for Valtec Corp. . . . **Barry R. Williams** had this to say, "Since graduation and until December, 1977, I helped run my family's luncheonette/restaurant in the Bronx, N.Y. After the neighborhood deteriorated, we closed, and in April, 1978, I started with I.B.M. in N.Y.C. as a systems engineer trainee (going to school again, but getting paid well for it this time), and I am doing well. I will be moving into the city soon if I can find someplace for reasonable rent."

Since leaving M.I.T. in June, 1977, **Bradford E. Hampson** has been employed at Prime Computer, Inc., in Newton, Mass., as a software engineer. His experience, he says, has so far been rewarding, and more importantly, fun. He's presently living in Marlboro and enjoying the change from city life. . . . I received a nice note from **Bob Graber** who said that he left Boston in February to take a job as a financial economist with the Securities and Exchange Commission in Washington, D.C. He's also taking graduate economics courses at the Dulles Airport extension of Virginia Polytech. He sends his regards to the class of 1975.

The sky's the limit for the following classmates. **Harlan R. Davis** is currently working for Braniff Airlines as Manager of Area Sales in Chicago. He has a private pilot license and has been taking advantage of the airline pass privileges. Thus far Harlan has taken two trips to Europe, one trip to South America, one trip to Hawaii, and many within the U.S. . . . **Alfred D. Lewis** '76 writes, "I am working for Rocketdyne Division of Rockwell International on the Space Shuttle program. I am also managing to keep my hand in playing hockey in some of the amateur hockey leagues along with Jim Paulson, '76." . . . **Noel A. Spishak** had this to say, "I have recently made a job change and I am now employed by the Boeing Aerospace Co. in the field of manufacturing research, located in Seattle, Wash. It is an experience seeing the majestic 14,000-ft. showcapped peak of Mt. Ranier from Seattle as if it was in my backyard." . . . **Chris Flanigan**, who works with General Dynamics Corp. in San Diego, is one of five members of the M.I.T. Rocket Society to be named to the nine member United States Space Model Team, scheduled to compete at the World Championships held September 1-5, 1978, in Bulgaria.

**Gil W. Sanchez** graduated from the University of California at Berkeley with an M.S. in chemical engineering and is now employed by Proctor and Gamble in Cincinnati, Ohio. . . . Here are some more Berkeleyites. **Henry S. Luftman**, **Dick Stratt** and **Bernie Brooks** are in their fourth year of the Ph.D. program in chemistry. **Al Sopelak** has received master's degrees in computer science and management science and has returned to Hartford, Conn. . . . **Chee K. Yap** says, "I'm at the graduate school in computer science at Yale. **Rick Granger** and **Jaime Carbonell** are the other third-year students here. Jaime has finished and will be an assistant professor (artificial intelligence) at Carnegie Mellon University next fall. I will be out at University of California in Berkeley next year to finish my dissertation." . . . **Keith Milkove** has just completed his first year in graduate school in the Materials Science and Engineering Department at Cornell University. He has seen several brass rats floating around campus (five in his quantum mechanics class, including the professor). He said, "If anyone stops by Cornell, look me up and I'll treat you to lunch." Guess there really is such a thing as a free lunch. . . . **Michael L. Bushnell** had a paper published in the July, 1977, issue of *Industrial Research* entitled "Computerized Thermal Mechanical Fatigue Testing." . . . **Karen Irwin Chen** is still in school, working on a Ph.D. in electrical engineering at, once again, U.C.-Berkeley. She says she is "having a wonderful time in the land of golden sunshine and flaming liberals."

And now for some medical scholars. **John G. Lundblad** is in his freshman year at the University of Minnesota Medical School at Minneapolis. . . . **Leonard Weiss** is currently in the third year of medical school at Wayne State University in Detroit. He did research two years ago in pharmacological nutrition at Wayne, and as of September, 1978, is taking a medical school elective in Boston in nutritional services at Deaconess Hospital. . . . Harvard Business School will be receiving **John Haynes** this fall. John has been working for two and a half years in energy conservation with the Commonwealth of Massachusetts. . . . And currently between years (at the time he wrote me) at the Harvard Business School is **Lew Weinstein**, who writes, "First year was great and I am spending an equally enjoyable summer at the Boston Consulting Group."

Some interesting items: From the *Daily Peabody Times*, Peabody, Mass., I learned that **David H. Lockwood** is our North American Tiddlywinks Champion. According to the article, he'll "risk $500.00 if anyone would like to challenge him to an 11-game match. He is reachable at his Edgewater, N.J., home, 201-224-9203." Come on all you would-be squidgers, squoppers, potters and piddlers! . . . And finally, entrepreneurs take note: our classmate, **Miles R. Fidelman** is a member of the M.I.T. Venture Forum Committee. The Forum is an entrepreneurial problem clinic initiated by M.I.T. alumni with staff support from the Alumni Association. Beginning in the fall, the Forum will offer alumni who have established on-going businesses or are operating existing ones that are at a critical stage of development the opportunity to obtain advice from alumni experts and others on possible steps to achieve their companies' goals.

That's all for now. Thanks for the letters. — **Jennifer Gordon**, Secretary, 22 Centre St. #9, Cambridge, Mass. 02139

# 76

First of all, my apologies to **Russell Chipman**. He sent me a letter in March which accidently got buried in the debris on my desk. Russell is working for Perkin-Elmer Corp. in Norwalk, Conn. At the time I got the letter, he had been appointed as the optical metrologist for the 2.4 meter aperture, "Space Telescope," that P.E. is building for N.A.S.A. He concludes that his "hard work and long nights at the George Wallace Observatory are paying off handsomely."

On July 1 (a Saturday night) I bumped into **Eric Zweigel**, in from Rochester for the long weekend, at Crickets, one of Boston's better singles' bars. He told me that he had been working hard and was now looking forward to some fun. He also said that Boston women are better groomed than those in Rochester.

I have the pleasure of reporting that **Dan Dershowitz** will wed Debra Gross, '77, on December 25, 1978. Dan is currently working part time for Polaroid and doing research for his Ph.D. thesis at the 'Tute. Debbie has her M.B.A. from the University of Chicago this December.

From the mails: **Roger Allison** writes that he went on active duty with the army after graduation. He was initially at the engineer officer basic course at Ft. Belvoir, Va. After finishing that, he spent 15 months as a platoon leader in a combat engineering battalion. He is now working in the environmental office of the post engineers at Ft. Lewis, Wash.

**Melissa Weiksnar** has sent an interesting letter: ". . . I was in Washington, D.C., to march and lobby for the Equal Rights Amendment. It truly amazes me that I got through 16 years of 'education' without ever being informed that women are

**Four Years from Three M.I.T. Degrees to Head of the State's Public Utilities**

Early this year, Paul F. Levy, '74, then Commissioner of the Department of Public Utilities, wrote in *Technology Review* (*February, pp. 36-43*) that "peak-period pricing" of electricity — the plan for utilities to charge more for electricity at times of high demand than low — would probably reduce the need for new generating capacity and keep down the cost of electricity.

Now his job, as newly-appointed Chairman of the D.P.U., is to put such a plan into effect in Massachusetts under a mandate of the State's Supreme Judicial Court, the first such statewide order in the U.S.

After finishing three degrees at M.I.T. (S.B.s in economics and urban studies and an S.M. in city planning), Mr. Levy spent three years as Deputy Director of the Massachusetts Energy Office, where he gained his "special expertise" in time-of-day electric pricing. Then came his appointment — at the age of 27 — to be Commissioner of Public Utilities — and six months later his elevation to that Department's Chairmanship.

Interviewed this summer by James Worsham of the *Boston Globe*, Mr. Levy said he "always wanted to be involved in government," and that concern obviously motivated his choices at M.I.T. He likes the level of state government: "The federal government is too big and too far removed from day-to-day activities and has too little accountability," Mr. Levy told Mr. Worsham. "In state government, the individual has more of a chance to make a difference."

His goal in the D.P.U., says Mr. Levy, is "to try to bring a sense of policy . . . to initiate proceedings and make sure the results of ongoing proceedings are in consonance with state policy."

In the State House, Mr. Levy's choice was a popular one. Henry Lee, Director of the Massachusetts Energy Office, says Mr. Levy is "the brightest guy I've worked with in state government in ten years." Mr. Lee credits Mr. Levy's writing ability with the success of proposals which brought the Energy Office nearly $3 million in federal grants. "I've always looked on everything we've achieved in this office as one-half Paul Levy, and maybe more," Mr. Lee told the *Globe*.

not included in the constitution. . . . I'll be going to Austin in August with a group from N.O.W. (National Organization for Women) to testify on sexist content in textbooks. . . . I urge all out there who are considering marriage to get out their I.R.S. tables. It will probably cost the average M.I.T. couple about $50 per month more in federal taxes than if they were cohabbing. Also, advise anyone moving to a community-property state to make sure they can live within the system."

Ensign **Jeff Mitchell** has sent a postcard from Marseille, France. Ah, the life of the sailor, cruising the seas! He writes that he has been to Rota, Spain; Catania, Sicily; Souda Bay, Crete; Naples, Italy; and Marseille. Marseille apparently was the best, featuring "very friendly people, good wine, bread, cheese, beaches, etc." Jeff is now the R division officer on the U.S.S. Forrestal, responsible for "112 men and 1,000 heads to fix, as well as metalwork, carpentry, piping, and other assorted jobs." . . . **Joe Abeles** has mailed a postcard from Mt. Sinai, Israel. He has been using some of his time in Israel to snorkel in the Gulf of Eilat and to climb mountains.

From **George Troychak**, ". . . working for Rockwell on the Sabreliner 65 business jet as an aeronautical engineer (structural load analysis). I am enjoying the sun and beaches of Southern California. I am also taking flying instruction leading to commercial certificate and instrument rating." . . . **Timothy Allen** writes that he is working for Keydata in Watertown, Mass., as a systems programmer, and that this summer he spent five weeks with the U.S. Army Reserve in various camps and schools.

**Richard Lopiccolo** finished his thesis in September, 1976, and then joined the Naval Nuclear Power Program. He was commissioned an ensign on April 1, 1977, and finished his training at the Naval Nuclear Power School in Orlando, Fla., in October, 1977. He was then transferred to the Naval Nuclear Power Training Unit in Windsor, Conn., in November, 1977; qualified as an Engineer Officer of the Watch on Naval Nuclear Propulsion Systems; graduated from that program in April, 1978. Next he commenced training at the Naval Submarine School, New London, Conn., in May, 1978, and finished that program in August, 1978. Richard will be stationed on the nuclear fast attack submarine *U.S.S. Silversides* out of Norfolk, Va.

**Zachary Levine** has passed his doctoral preliminaries at the department of physics at the University of Pennsylvania. He enjoys "the congenial atmosphere of both students and faculty."

**James Wadja** is in Illinois learning about and writing software for Sears, Roebuck.

**Albert Oliver,Jr.**, has got his master of architecture degree from the University of California. His master's thesis is "all about discos!" That must have been fun to research.

**Sam Price III** is a 2nd lieutenant in a combat support hospital (formerly called a M.A.S.H.). He is responsible for patient administration and readiness to move the camp. He says he "must be able to move 500,000 lbs. and 244 people, including 29 nurses, anywhere in the world." Phew! . . . **Jeslie Chermak** has finished at the University of California at Los Angeles with an M.S. in computer science. He "missed the seasons down here in Southern California. While you folks were buried in snow, down here we were nearly drowned in continual rains. Give me a blizzard any old day — I prefer to do my swimming in the ocean and pools."

**Susan Smolinski** is an engineer with Shell Oil at their southern exploration and production region in New Orleans. . . . **Robert Steininger** has finished his M.S. in chemical engineering at the University of California in Berkeley. . . . **Fred Walter** is playing hockey for their club team and studying astronomy. . . . And **Jonathan Maybaum** is a graduate student in pharmaceutical chemistry at the University of California in San Francisco.

**Michael Risimondo** got his M.B.A. from the University of Washington in March, and at the time of his note, was looking for work in Seattle. . . . **Lloyd Saunders III** finished an M.B.A. at Stanford last June. The summer he spent travelling through Europe, and then, in September, he started working with Goldman, Sachs and Co. in New York City, in the corporate finance department. Lloyd closed with, "Stanford was great; the weather was super; people sharp, and the experience well worth it."

**Norman Lambert** finished the 'Tute in January, 1977, and for the next 14 months worked for Bendix Avionics in Ft. Lauderdale. He then moved to Orlando, where he works for Martin Marietta as a mechanical engineer on defense projects. . . . **Pat Foley** has been awarded a Collamore-Rogers Fellowship for further graduate study at the 'Tute. Her graduate studies in civil engineering revolve around measuring and analyzing the effects of U.S. government actions on the domestic copper industry.

I have a partly decipherable note from **Ron Salomon**, which I found distressing. "Notwithstanding my high scholastic achievement at M.I.T., my work at Mass. General Hospital and later at Albert Einstein Medical School, I was not accepted for two years in a row to any of the medical schools I have applied (20), each of the two years! Perhaps M.I.T., scholastically, does not rate high in the eyes of the medical schools of this country! Or is it that a 'white male' has reached the bottom of the chances in the selection process? I am now in Belgium thanks to my perseverance; I was accepted at all three of their medical schools. I hope to learn 'something' here." The rest of his note was damaged in the mails.

Joanne and **Dave Campanella** have moved back to Boston (Brighton) from New Orleans. Dave is now working for Ionics in Watertown. . . . Lori and **Steve Edelson** have also moved back. Steve has left his job with Watkins Johnson in Gaithersburg, Md., and is "being sent up the river for two years of hard labor at the Harvard Business School."

Just before these notes were due, I got a call from **Erland van Lidth de Jeude**. While on his way to securing the No. 1 amateur heavyweight wrestler title in the U.S., an opponent cracked one of his ribs, sidelining Erland from some upcoming international competition. He is still with A.D.P. Network Services in N.Y.C.

As for your Secretary, he has been examining office sites in Boston's financial district for his firm, Endymion Commodities, Inc., plus dickering for a line of credit. It appears that he is going to open an office on State St. by September 1.

Remember, if more of you would write, we would have more news. So don't be shy. — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

# 78

Greetings all. First, we have news from **Peter Lippitt** in Sweden. After graduation Peter returned there (he spent his junior year abroad) to play professional basketball and to teach the game to children. He remarked that Swedish children have difficulty learning the game due to their natural tendency to kick the ball. At least they don't try to head it.

**Sharon Pastoriza** and **Doug King** recently announced their engagement. Rumor has it that the wedding is planned for this coming spring. Doug will be working for Chevron in Richmond, Calif. (near Berkeley).

Three classmates, **Geoff Landis**, **Bob Parks** and **Harold Youngren**, have been appointed to the U.S. Space Model Team. (All three are members of the M.I.T. Rocketry Club.) The nine-member team will compete in the World Championships to take place this fall in Bulgaria.

My travels this summer brought me into contact with several members of the class. In sunny San Diego I visited **Spahr Webb** who is studying at Scripps Oceanographic Institute. Spahr spent the summer sailing in Hawaii and on the Great Lakes, but he complains that in San Diego the weather is too mild for sailing until mid-autumn. He is also worried that he'll have difficulty getting work done with the beach so close to school. We should all have such problems. (**Pete Shaw**, Spahr's former roommate, will also be at Scripps.)

My travels later brought me to Chicago where **Sandi Haber** and **Jennifer Jonas** spent the summer. Sandi and Jen were working for a small pharmaceutical firm and were next-door neighbors in a small college dormitory. In the fall Sandi will be at Wharton Business School in Philadelphia; Jen will study chemical engineering at the University of California in Berkeley. . . . Occasional evenings at the disco were spent with **Rick Losk** and **John Richardson**, both of whom have taken jobs in the area.

While wandering about on the Northwestern University campus I ran into **Mark James**, who is going to the journalism school there. They apparently kept him busy even over the summer — when I saw him he was preparing to rush off and interview someone for an important "scoop."

My scouts and spies have been busily collecting information on the whereabouts of many of our classmates. I report them here, listed by area of the country.

*The Boston Area*: **Paul Bayless** and **Steve Piet** are continuing at M.I.T. in a five year program in nuclear engineering. **Steve Donato** will stay on at M.I.T. in the Sloan School of Management. **Linda Dornbrook** is working for Polaroid in Cambridge. **Kevin Fallon** is staying on at the tute for his master's in chemical engineering. **Jennifer Hall** is studying geophysics at M.I.T. under an Ida M. Green fellowship. **Whit Halstead** will stay on in the mechanical engineering department. **Karen Hladik** will study economics at Harvard, where **Hector Picon** will be studying medicine.

*Elsewhere in the Northeast*: **Ted Austell** will be at Carnegie-Mellon University in Pittsburg, studying management. **Steve Brigham** will be at Columbia Medical School. **Rob Indik** is studying mathematics at Princeton. **Don Lapin** is working for United Technologies in Hartford, Conn. **Dan Rahman** will be at the New York College of Medicine in northern Westchester County. **Neil Rockowitz** is in medical school at McGill University (Montreal). **Roby Rosen** and **Moshe Sadofsky** are at the University of Pennsylvania Medical School. **Emil Shen** is in the chemical engineering graduate school at Lehigh. **Ruthie Shragowitz** has an amazing job working for an architectural firm in Baltimore, Md. And, **Steve Stein** is at the University of Connecticut Medical School.

*In the South*: **Mark Smith** is studying electrical engineering at Georgia Tech; **Catherine Chiles** is at the University of North Carolina Medical School in Chapel Hill; and three students are at the Vanderbilt Medical School in Tennessee — **Bill Prichard**, **Miller Batson** and **Carl Hampf**.

In Houston, Tex. we have five classmates. **John Marcou** and his former roommate, **Todd Buikema**, will be working for Slumberger. **Jack Perini** and **Beth Plasse** will be at Shell Oil, and **Laurie Turkanis** will be at Bechtel Engineering. Elsewhere in Texas, Slumberger is training **Stan Rubin** in Midland (and will subsequently transfer him to Long Beach, Calif.). **Phil Kesten**, working for Slumberger in Corpus Christi, along with **Frances Scovil**, says that he'll soon apply for a transfer to Long Beach, too.

*In the Great Midwest*: **Celia Berry** will be at Northwestern, **Steve Lawrence** at the University of Michigan Law School and **Dave Karp** in an M.D.-Ph.D. program at Washington University in St. Louis. **Naomi Johnson** is working for an architectural firm in Detroit, **Vince James** for Proctor and Gamble in Cincinnati and **Claude Wagner** for Goodyear in Akron, Ohio. **Paul O'Brien** is studying economics at the University of Minnesota.

*On the West Coast*: **Bill Kath** is in graduate school (mathematics) at Caltech; **Bob Lafyatis** is in San Francisco and **Mike Templeton** is studying for his doctorate in chemical engineering at Caltech. At the University of California in Berkeley will be **Sue Hanson** (in civil engineering) and **Earl T. Cohen** and **Dan Halbert** (in computer science).

I've obviously left out hundreds of people and probably made dozens of mistakes in the notes above. Don't be left out — send me news about where you're living or working. Let me tell people where you are; even if it's in the depths of Sheboygan, there may be somebody you know nearby. — **David S. Browne**, Secretary, Rm. p-21, 551 South State St., Ann Arbor, Mich. 48109

# Courses

## I
### Civil Engineering

**Jack Price,** S.M. '58, writes to inform us that he has been reassigned to base commander at Patrick Air Force Base in Florida . . . **Glenn Kriger,** S.M. '76, is employed by Earl and Wright in San Francisco. His current assignment is the design of an offshore platform for gas-oil production. The platform will be located off the coast of New Zealand.

## II
### Mechanical Engineering

**W. Peter Teagan,** Ph.D. '63, senior consultant with Arthur D. Little, recently completed a two-week tour in Egypt meeting with Egyptian specialists in solar heating, photovoltaics, and wind power. Dr. Teagan is heading a solar energy task force appointed by the Department of Energy to study energy resources in developing countries. Egypt's Ministry of Electricity arranged visits to a rural village in the Nile Delta and to an electronics plant near Cairo . . . **Leopold Engler,** S.M. '54, has been promoted to vice president of operations for the precision products division of Northrop Corp. He joined the company in 1962 as a production engineering supervisor.

**James B. Matthews,** S.M. '59, has been appointed chairman of the department of mechanical engineering at Western Michigan University. Since June, 1977, Dr. Matthews has been on leave from the Rose-Hulman Institute of Technology for an assignment with Ford Motor Co., where he was a principal design engineer working on new engine concepts . . . **John C. Chato,** Ph.D. '60, left for Switzerland this summer on a Fogarty Senior International Fellowship. He will spend nine months in Zurich working at the Biomedical Engineering Institute.

## IV
### Architecture

**Richard N. Seligman,** M.A.A. '72, is principal of Richard Seligman and Associates, a planning and design consulting company in Toronto. Ongoing projects are the preplanning, conceptual design, research and development coordination of several residential developments in Toronto. The company also manages a major theatre . . . **Visvaldis Paukulis,** M.Ar. '55, has joined The Ritchie Organisation, an architectural and planning company, as a project director. He is currently working on the health care facility for the Center for Women and Children in Pittsburgh. Among Mr. Paukulis' professional achievements is the Paukulis Planning System, a copyrighted modular construction system that can be constructed in concrete, steel frame, or wood.

## V
### Chemistry

**J. Robert Pipal,** Ph.D. '71, has been appointed assistant professor of chemistry at Grinnell College. He comes most recently from the University of Virginia . . . **John T. Viola,** Ph.D. '67, has received his third award of the Meritorious Service Medal at Hanscom A.F.B. The colonel now serves as director of business management . . . **John E. Sheats,** Ph.D. '66, is co-editor of "Organometallic Polymers", published by Academic Press, 1978. Dr. Sheats was recently promoted to professor of chemistry at Rider College.

**Ira A. Lavit Michaels,** Ph.D. '74, began his medical internship at Albert Einstein College of Medicine this summer . . . **Marion O'Leary,** Ph.D. '66, was on a sabbatical for a year, initiating a research program in photosynthesis. She is now professor of chemistry at the University of Wisconsin in Madison . . . **Vladimirs Zale,** S.M. '57, is a chemist with O.S.H.A. Analytical Laboratory in Salt Lake City.

**John T. Marvel,** Ph.D. '64, formerly manager of chemical synthesis at Monsanto Agricultural Products Co., has been promoted to associate director of research with responsibility for new products research . . . **Donald M. Black,** Ph.D. '47, has been appointed operations manager for the eastern region of McKesson Chemical Co. Mr. Black has two sons who also are/will be alumni. Son number one is a '71 graduate who is a patent attorney for a New York firm. Son number two expects to receive his degree in 1980.

**James W. Beatty, Jr.,** Ph.D. '60, professor of chemistry at Rice College, has been elected vice president and president elect of the Wisconsin College of American Association of University Professors. . . **Donald Mattison,** S.M. '68, was recently appointed head for the section of reproductive toxicology at the National Institute of Child Health and Human Development. He writes that his research interests are chemical carcinogens.

## VI
### Electrical Engineering and Computer Science

**Rudolph C. Drechsler,** S.M. '65, is the co-author of "Suppressing Echoes Digital Style," published in the Bell Laboratories Record. The article promises that we will hear less echoes on the telephone lines in the future, due to the development of a new echo suppressor terminal. . . **Charles W. Merriam,** Sc.D. '55, chairman of the department of electrical engineering, at the University of Rochester, has written a new book entitled "FORTRAN Computer Problems: Solutions to Optimization Problems Arising in Feedback Control," published by D. C. Heath and Co. . . **Teddy Huang,** E.E. '68, has been promoted to supervisor of the test facility group in the Operation Systems Laboratory of Bell Labs.

### An M.I.T. Chemist for Lafayette College

When **David W. Ellis,** Ph.D. '62, left M.I.T. with a shiny new doctorate in chemistry in his hands, he knew only that he was headed for an academic career — teaching, research, and perhaps (eventually) administration — at the University of New Hampshire. Within five years he was promoted to Associate Professor and was busy in all three of those things; and then teaching and research fell by the wayside as Dr. Ellis became Provost (1971) and then Vice President for Academic Affairs at U.N.H.

This fall he's beginning a new career as President of Lafayette College in Easton, Pa., which he describes as "a small, personal college with much of the diversity in program of a university . . . an unusual blending of the arts, sciences, and engineering." That's what attracted him to Lafayette, says Dr. Ellis: "Young people need an education which has breadth as well as depth and which prepares them for functioning as effective adults in a complex world."

### Masamune Joins Chemistry

**Satoru Masamune,** a specialist in the structure and synthesis of complex organic molecules, has joined M.I.T. as Professor of Chemistry.

A native of Japan, Dr. Masamune studied at Tohoku University (B.Sc. 1952) and the University of California, Berkeley (Ph.D. 1957). Since then he has taught at the University of Wisconsin, Carnegie Mellon University, and the University of Alberta, Canada, where he has been a member of the Chemistry Department since 1964. In addition, he's held visiting professorships at Osaka University, Japan, and the University of Texas in Austin, and in 1976 he was Purves Lecturer at McGill University, Montreal. Early this year Dr. Masamune received the American Chemical Society Award for his "creative work in synthetic organic chemistry."

### Designing a New Capital in America's Last Wilderness

When Alaskans vote in November on a $966 million bond issue to build a wholly new $2 billion state capital city in the shadow of Mount McKinley, they'll be voting on a plan of which M.I.T. alumni have been among the chief architects.

It was a planning assignment unique in the history of the profession — a problem of which planners' dreams are dreamt: a completely new city to be built in a spectacularly beautiful wilderness area.

*A City of 37,500 in 15 Years*

Four years ago Alaska's voters agreed to relocate their state capital from Juneau in the Alaska "panhandle," at least 500 miles from the population centers of Anchorage and Fairbanks, to West Alaska. Two years later a Site Selection Committee proposed — and the voters accepted — an area in the Susitna River valley near Willow, whose population was then under 50.

Next came the planning stage, managed by **Morton S. Hoppenfeld,** '52, as Executive Director of a Capital Site Planning Commission; he took a year's leave from his job as Dean of Architecture and Planning at University of New Mexico. The process began when ten teams (out of 160 who had sent in their qualifications) were called to Anchorage in October, 1977. Five survived this screening, and each was asked to return six breathless weeks later with a conceptual master plan for the new city.

Among the five was a team of Bull Field Volkmann Stockwell, architects and planners, and the firm of Sedway/ Cooke, city planners, in San Francisco. **Henrik Bull,** '51, and **Sherwood B. ("Woody") Stockwell,** '49, are senior principals of the former, and there were also major contributions from their colleagues John Field and Michael Pyatok (the latter is visiting critic in the Department of Architecture at M.I.T.

By early this year this team's preliminary concept had been chosen by the Site Planning Commission, and theirs was the task of drawing the final blueprint for a city whose population would reach 37,500 by 1994 and in which 2 million square feet of government office space would be the major feature.

*Wilderness: Preservation and Access*

Here is Mr. Bull's own description of the final solution which is now before Alaska voters:

"The site, rolling terrain wooded with spruce and birch, is bisected by Deception Creek. In our plan, the Creek is to be a clear demarcation between developed and undeveloped areas; we place great emphasis on preservation and access to the wilderness.

"We located the town center on a ridge overlooking Deception Creek and the unspoiled wilderness. This location also enjoys a beautiful view of Mount McKinley, which — although 90 miles away — is very prominent on a clear day. The downtown was planned to maximize these views of Mount McKinley and the wilderness and also as much as possible to let in the low winter sun (6° above the horizon in December). All the buildings will be kept low, in scale with the trees and topography, with the higher buildings on the north side to bounce winter sun into the main street.

"The main street would have glass-enclosed arcades on the sunny side of the street, closeable during the winter, creating an enclosed, protected pedestrian path from one end of the town center to the other. In the commercial end of the town center there would be multiple-use buildings, with retail stores, restaurants, and other public areas on the ground floors, private offices on the second floors, and apartments above.

"Our plan was also unique among the entries in planning the entire town so that a very simple transit system could bring people to work conveniently (with no charge at the fare box). Even though we knew that independent-minded Alaskans would not give up their many automobiles, we realized that this situation would be almost unique in that everyone will work for the same employer — the state — and all in one spot. So we devised a system using small buses running on their own road network, with two-minute headways during commuting hours. About 80 per cent of the population will live within 1,000 feet of a bus stop. The downtown main street would be for buses and pedestrians only, with service streets at either side.

"Without such a public transit network, 10,000 parking spaces would have to be provided in the downtown core. We feel that this can easily be cut in half, since people will find that they can be driven from heated bus stops to the entrances of their places of work in less time than it would take to warm up their cars.

"Although actual design of buildings was not part of our assignment, we stated strongly that the capitol building, which we called The Commons, should symbolically be an inviting place where citizens could meet their legislators and other government people; the principal reason for moving the capital is to give more Alaskans greater access to their government. The distances here are truly staggering; Juneau is two time zones away from the center of the Alaskan population, which is in the Anchorage basin."

Will Alaskans accept these bold plans for a city in the wilderness? Mr. Bull admits there is opposition — especially in southeastern Alaska — despite the New Capital Planning Commission's conviction that "the cost estimates are "conservatively high."

"It will be interesting to see how the citizens will vote on the issue," is his noncommittal response to the question.

**Edward J. Craig,** Sc.D. '54, is chairman of the department of electrical engineering and computer science at Union College . . . **Adolfo Guzman,** Ph.D. '69, is also chairman of the computer science department, but at the National University of Mexico. Dr. Guzman writes that he is continuing work on computer analysis of satellite images for detection and estimation of national resources." . . . **Martin C. Hydinger,** S.M. '50, is president of the Hampton Roads Chapter of the Retired Officers Association.

**Thomas J. Warren,** S.M. '73, is working in Washington, D.C. as a staff engineer to the Verdin Communications System . . . Another alumnus in the Capital is **Wilbur L. Pritchard,** E.E. '52. He is president of Satellite Systems Engineering, a consulting firm in satellite communication . . . This year's GenRad Foundation Fellowship for graduate studies has been awarded to **Maurice Herlihy.** His special field of interest is the theory of computer operating systems, structure and design.

# VIII
## Physics

**David Finkelstein,** Ph.D. '53, on the physics faculty of Yeshiva University since 1960, has been appointed Dean of Natural Science. He is noted for his research in the area of quantum mechanics and relativity, and is currently involved in a project concerning "earthquake lightnings," the luminous phenomena often accompanying earthquakes . . .

*Max T. Weiss*

**Max T. Weiss,** Ph.D. '47, has been elected a vice president of The Aerospace Corp. He will serve as general manager of the corporation's laboratory operations . . . **R. Bruce Stevenson,** '55, has been promoted to group leader at Mitre.

**John W. Green,** S.M. '56, was awarded a J.D. from the Golden Gate University last May . . . **Martin J. Klein,** Ph.D. '48, recently gave a lecture at North Adams State College. It was entitled "Albert Einstein: A Portrait of the Scientist as a Young Man." Dr. Klein is professor of the history of physics and chairman of the department of the history of science and medicine at Yale. He is also an associate editor of the American Journal of Physics . . . **Lee Grodzins,** professor in the department, has been elected Councillor-at-large of the American Institute of Physics.

# IX
## Psychology

**Nancy Berman,** Ph.D. '72, assistant professor at the Medical College of Pennsylvania is the corecipient of a large grant awarded mainly from the National Eye Institute. The more than half a million dollars will be used to obtain a better understanding of how the brain processes the information it receives through the eyes. The two scientists are also investigating how the brain might be affected by what an animal sees at an early age. This is expected to lead to better therapy for infants born with visual defects or brain injuries . . . **Donald W. Pfaff,** Ph.D. '65, has been appointed a professor at The Rockefeller University. His research interests centers on the effects of steroid hormones on nerve cells in relation to reproductive behavior.

*Nancy Berman*

# X
## Chemical Engineering

**Giles R. Cokelet,** Sc.D. '63, leaves Montana State University for the University of Rochester where he has been appointed professor of radiation biology and biophysics and of chemical engineering. He is a widely recognized authority on blood flow . . . **Uri Drimmer,** S.M. '56, is a consultant to the food and chemical industry in Tel-Aviv, where he lives with his wife and three children. He also represents several American firms which supply process equipment to those industries . . . **Nicholas A. Peppas,** Sc.D. '74, has been with the school of chemical engineering of Purdue University since June 1976. This June he was promoted to tenured associate professor. Dr. Pappas was also the recipient of the 1978 A. A. Potter Best of Engineering Professors Award, and the R. N. Shreve Award at Purdue.

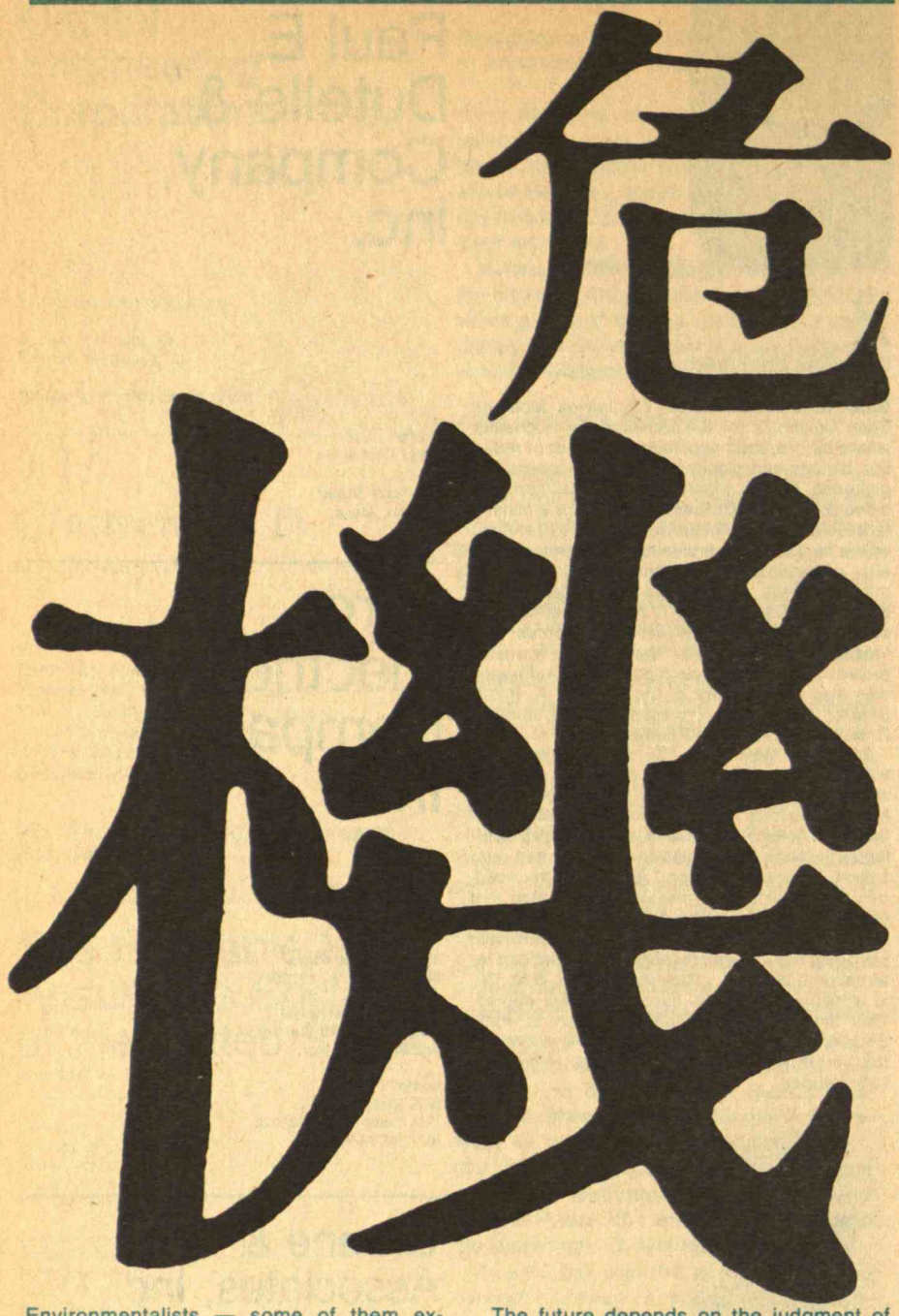
**Walter G. May,** Sc.D. '49, senior scientific advisor at Exxon, was recently elected to membership at the National Academy of Engineering "for his contributions to engineering theory and practice in the fields of fluidization, high-energy propellants, liquified natural gas technology, and centrifugal isotope separation." Election to the Academy is the highest professional distinction that can be conferred on an engineer . . . **Allan H. Bergman,** S.M. '58, has been promoted to vice president and general manager of Permabond International Group . . . **Richard Rosera,** S.M. '70, is working towards his second masters degree. This time in business administration at Penn State. In addition to his studies, he is also a chemical manufacturing manager for Whitmore Laboratories.

*Walter G. May*

# XIII
## Ocean Engineering

**Oliver H. Porter,** S.M. '66, senior program officer at the Naval Underwater Systems Center, has become officer in charge of the Newport laboratory. He has been with the center since 1976. Before that he served in various development positions, among them as preliminary design director of the Trident submarine. Commander Porter relieves **William E. Trueblood,** N.E. '58, who has been assigned to Washington, D.C. as major project manager of N.A.T.O.'s patrol hydrofoil ship acquisition project. . . **Michael R. Donovan,** S.M. '75, is M-division officer in U.S.S. Bainbridge; he just returned home from a west Pacific cruise.

From Virginia Beach comes a note signed **Lawrence L. Laine,** N.E. '67. He has been awarded a second master's degree, this time in industrial



Environmentalists — some of them extremists and some fair-minded critics — have created a crisis for chemical engineers. The way they use their "tremendous power to alter the environment" will more than any other factor affect the success of technology in the next 100 years, says Professor **James Wei,** Sc.D. '55, Head of the Department of Chemical Engineering, in *Chemtech* (June, 1978).

Professor Wei's response is to call attention to the Chinese word for "crisis" which is the heading for this summary of his views; one of the two characters means "threat," the other "opportunity."

"A crisis is always both a threat and an opportunity," writes Professor Wei, "and the environmental crisis is the best of times for chemical technologists who can seize the opportunity to contain the threats."

The future depends on the judgment of three decisionmakers. One is the engineer, who has studied science and engineering so that he can build a safe, efficient, dependable plant. Another is the consumer, who by the ring of the cash register is made "economically sovereign" in this land. And the third is the voter, going to the polls. The engineer's job is to serve all three goals, and he can do so by asking himself three questions:

- ☐ How does my work benefit the public?
- ☐ Can my work possibly harm the public?
- ☐ How can I increase the benefit, and decrease the harm?

"The future will belong to the chemical engineers who know how to serve the public," says Dr. Wei.

management . . . The Navy informs us that **Peter B. Fontneau,** S.M. '76, recently visited Anchorage, Alaska, on board the Coast Guard cutter Morgenthau, where he is an engineering officer . . . **John E. Halkyard,** Sc.D. '72, is manager of the Manganese Nodule Project for Kennecott Copper Corp. in San Diego.

## XIV
### Economics

Lawrence University presented **James D. Dana,** Ph.D. '60, with its Excellent Teaching Award. The recipient was not known until he was announced at the commencement exercises. This is the second honor bestowed on Dana recently; he was also named to the John R. Kimberly Distinguished Professorship in The American Economic System . . . The National Academy of Sciences has elected **Thomas F. Malone,** Sc.D. '46 to a four-year term as foreign secretary. Malone is director of the Holcomb Research Institute at Butler University and a former vice president of the International Council of Scientific Unions.

## XV
### Management

**Kenneth A. Charon,** S.M. '66, was recently promoted to a vice president at I.B.M. in Paris . . . **Ralph N. Bussard,** S.M. '69, is transferring from the Atlanta to the Houston office of Price Waterhouse and Co. . . . **Ruth E. Rowan,** S.M. '77, has been named a financial analyst for the materials division of Norton Co. Earlier in her career, Ms. Rowan was an economist in the U.S. Bureau of Labor Statistics and a budget analyst in the Congressional Budget Office . . . **John W. Anderson,** S.M. '67, has been appointed president of the G.T.E. precision materials group. He started with the company in 1954. In his new position he will continue to be located at the group's headquarters in Danvers, Mass.

*Bruce E. Stangle*

**Bruce E. Stangle,** Ph.D. '74, has joined the managerial economics staff of Arthur D. Little. Before that, he worked as a consultant to the company on a project concerning the economic impact

on the chemical industry from proposed environmental regulations . . . **Albert H. Jacobson** S.M. '52 has an additional degree: a Ph.D. from Stanford University.

*Ormand J. Wade*

**Ormand J. Wade,** S.M. '73, has been elected vice president-staff for the American Telephone and Telegraph Co.'s Long Lines Department. He began his Bell System career in 1961, as a student engineer . . . A note from **Peter J. Rousselle,** S.M. '69 reads, "Just returned from two years in the Philippines as consultant to the government's population program. Now back in Boston as vice president and treasurer of Management Sciences for Health, a non-profit foundation that provides technical assistance to developing countries."

# XVI

## Aeronautics and Astronautics

**John Marshall,** S.M. '73, was one of the three Sikorsky Aircraft crew members killed in the tragic helicopter accident last May. He had been with Sikorsky since 1973. We extend our sympathy to his wife, Ruth Ann, and to his parents . . . **Shan-Fu Shen,** Sc.D. '49, has been elected the John Edson Sweet professor of engineering at Cornell University. He joined the Cornell faculty in 1961, and he also has held appointments at the universities of Paris and Vienna . . . **James P. Reilly,** Sc.D. '63, has joined W. J. Schafer Associates, Inc. as vice president of science and engineering. He comes most recently from Avco Everett Research Laboratory. Dr. Reilly is the inventor of the basic ionizer-sustainer electric discharge concept which is implemented in all E-beam sustainer electric discharge laser devices . . . **Robert A. Summers,** Sc.D. '54, is executive director at the Department of Energy for the research and development coordination council.

**William H. Cullin,** S.M. '47, is the author of "How to Conduct Foreign Military Sales: The '78-'79 United States Guide", distributed by Cucumber Bookshops, Inc., in Rockville, Maryland. Professor Cullin is currently on the faculty of Defense Systems Management College . . . **Philip D. Shutler,** S.M. '64, has been promoted to lieutenant general and assigned as Director, J-3, Joint Chiefs of Staff, at the Pentagon.

*When the man who supervised the design of the first airplane to fly the Atlantic met the man who developed the guidance systems used by U.S. astronauts to reach the moon, what did they say to each other? Not very much, as it turns out; they're old friends: "Hi, Jerry!" and "Hi, 'Doc'!" Professors Jerome C. Hunsaker, '12, and Charles S. Draper, '26 — they're seated left and right, respectively, in this picture — were among 150 members of the M.I.T. community at a party to honor Rene H. Miller, H. N. Slater Professor of Flight Transportation, upon his retirement as Head of the Department of Aeronautics and Astronautics this summer. It turned out to be the occasion for this historic picture — all six heads of the Department in its 49-year history in a single photograph. In addition to Professors Draper (1951-66) and Hunsaker (1933-51), the picture shows (standing, right to left) Professor Jack L. Kerrebrock, who became Head on July 1; Professor Miller (1968-1978), Raymond L. Bisplinghoff (1966-68) who is now Director of Research and Development at TYCO Laboratories, Inc., and (seated, center) Professor C. Fayette Taylor, '29 (1929-33). Professor Miller, who professed to be "stunned" by the reception accorded him, said his term as Head of the Department was "the most interesting period of my life — and one of the most difficult." (Photo: Calvin Campbell)*

### A Nod to M.I.T. from the Weathermen

Its 1978 award for "outstanding services to meteorology" has come to the M.I.T. Department of Meteorology from the American Meteorological Society. The citation is for the Department's "leadership in meteorological education since the founding in 1928 of the first academic meteorology department in the U.S." at M.I.T. The A.M.S. mentioned research and teaching on the general circulation of the atmosphere, geophysical fluid mechanics (the basis of numerical weather prediction), radar as a tool in cloud physics and mesometeorology, and climate change.

### A New Register of Geology Alumni: More Than 1,200 Names Worldwide

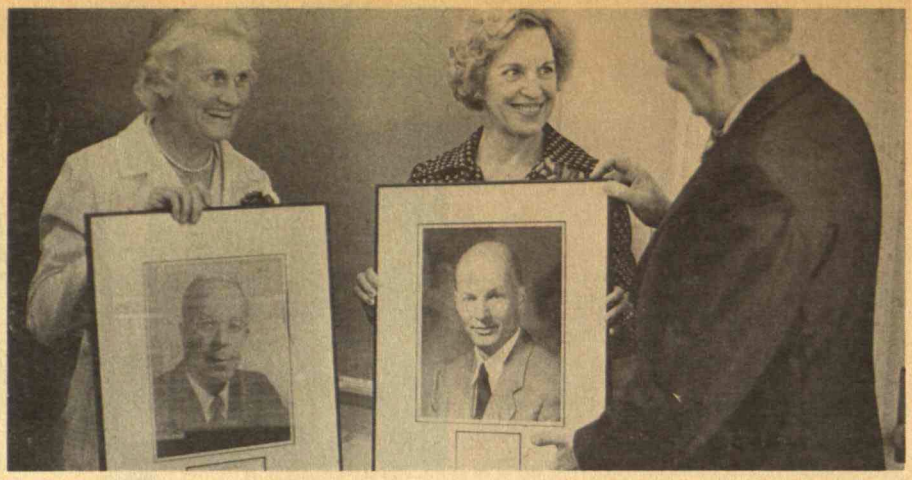
Everything the Department of Earth and Planetary Sciences knows about its more-than 1,200 alumni has now been compiled into a new *Register* (1865;1977) of the Department by Robert R. Shrock, Professor Emeritus.

In just over 200 pages are brief biographies (to the extent of available information) of every alumnus and indexes by years and by place of current residence. In addition, there's a brief history of the Department, a roster of present faculty and changes since 1965, a list of major benefactions, a summary of current research, and a compilation of the 2,490 degrees awarded in geology, planetary science, and oceanography since 1890 (including degrees given jointly with Woods Hole Oceanographic Institution under the joint program in oceanography since 1967).

The graduates are everywhere — in 45 states of the U.S., seven Canadaian provinces, and 38 foreign countries. After Massachusetts, most live in California (128) and Texas (75); then comes New York (55). Generoso R. Oca, S.M. '53, is Senior Engineering Geologist with the Philippines Bureau of Mines; James E. Everett, S.M. '62, is a geophysicist with West Australian Petroleum in Perth; Victor A. Wynne, '12, is reported to have "a farm in Kenscoff, near Port-au-Prince, Haiti, from which he produces 'delicious strawberry preserves.' "

To compile his new Register, Professor Shrock sent questionnaires to some 1,060 alumni for whom addresses were available; he had replies from — or information about — 85 per cent of these, a remarkable rate of return. Addresses and other information are lacking for only 15 per cent of all living alumni of the Department.

*(Professor Shrock will bring the* Register *up to date by reporting recent changes in the Department's alumni "family," a feature which he has happily promised to contribute to the* Review *as frequently as information justifies. — Ed.)*



*When M.I.T.'s research reactor was brand new, just 20 years ago, portraits were made if its two principal advocates and designers — Professor Manson Benedict, Ph.D. '35, who was the Head of the Department of Nuclear Engineering, and the late Professor Theos J. Thompson, the first Director of the Reactor; he was later to be killed in an airplane crash while on Atomic Energy Commission business. At a ceremony to celebrate the reactor's 20th birthday, the portraits were presented by Thomas F. Jones, Jr., Sc.D. '52, Vice President for Research, to Mrs. Benedict (left) and Mrs. Thompson. (Photo: Calvin Campbell)*

### Toward a Global Network on Nutrition

The Department of Nutrition and Food Science at M.I.T. has joined with the Harvard School of Public Health to form an M.I.T.-Harvard International Food and Nutrition Policy Program (I.F.N.P.), and I.F.N.P. has in turn completed an agreement for collaborative work with the United Nations University, Tokyo. The goal is to create a global network of institutions concerned with alleviating world hunger.

To the M.I.T.-Harvard collaboration, M.I.T. brings special strengths in food science, food economics, development economics, international policy analysis, systems analysis, anthropology, and some aspects of urban studies. Harvard's complementary interests are in maternal and child health, family planning, nutrition, population dynamics, food economics, epidemiology, and tropical health.

Under the agreement, advanced fellows from the United Nations University will come to the Boston area for work in food and nutrition policy and planning.

Dr. **Nevin S. Scrimshaw,** Head of the Department of Nutrition and Food Science, represents M.I.T. in the I.F.N.P., while Harvard's participation is the responsibility of Dr. Joe D. Wray, Acting Chairman of the Department of Population Sciences. **Barbara Underwood,** Associate Professor of Nutrition and Food Science at M.I.T., is coordinator.

# XX

### Nutrition and Food Sciences

**Leroy D. Cagnone,** Ph.D. '69, has been named acting dean at the University of the Pacific School of Dentistry in San Francisco. He became a member of the faculty in 1967 and holds an appointment as associate professor of biochemistry and community dentistry. In 1970 he was appointed assistant dean, and he has also served the school as director of continuing education programs . . . **David Lewis Johnson,** S.M. '76, recently received a doctor of medicine degree from Hahnemann Medical College and Hospital in Philadelphia. He will complete a psychiatry residency at Temple University.

# XXII

### Nuclear Engineering

**John M. Reade,** S.M. '69, will be responsible for the planning and implementing of product and market development programs for resource recovery business at Air Products and Chemicals, Inc., as he is appointed manager in the environmental products department . . . A note from **William J. Emrich, Jr.,** S.M. '74, tells us that he is "currently working on the physics design of a large H.T.G.R. nuclear power plant." . . . **Frederick H. Hauck,** S.M. '66, reported for training at N.A.S.A.'s Johnson Space Center in Houston on July 1. He is one of 15 pilots, and 35 astronauts altogether, selected by N.A.S.A. for the planned space shuttle. The group will be eligible for flights in 1980, the second year of operations. By 1985, as many as 60 shuttle flights a year are expected to be launched into orbit . . . The American Society for Engineering Education has selected **Robert P. Morgan,** Nu. E. '59, to receive the 1978 Chester F. Carlson Award. Professor Morgan is chairman of the Department of Technology and Human Affairs and director of the Center for Development Technology at Washington University in St. Louis. He joined the faculty in 1968 to research and teach the social application and impact of technology. Under his leadership, degree programs in technology and human affairs were created at the university.

*Robert P. Morgan*

**James Champy Resigns as Executive Vice President of Alumni Association; Committee seeks successor**

James A. Champy, '63, Executive Vice President of the M.I.T. Alumni Association since January, 1975, will leave in mid-October to return to private business.

"Jim's resignation is a distinct loss to our Association," writes Joe F. Moore, '52, President of the M.I.T. Alumni Association

A seven-member search committee has been established to identify and to screen possible successors, and Mr. Moore urges all those interested in the process either for themselves or others to make their interest known.

"The position of Alumni Association Executive Vice President is that of permanent head of the 50-member Association staff in Cambridge and corresponds approximately to a Vice Presidential position within the Institute itself," explains Mr. Moore. "It entails top operational management of a variety of activities including the *Technology Review*, Alumni Fund, Alumni Information System, and special Alumni functions. The Executive Vice President is responsible for implementing virtually all alumni relations programs and for regular reporting of alumni affairs and interests to the Chancellor."

Mr. Moore urges alumni to consider their interest in this position and to advise other potential candidates of its availability. "An expression of interest on the part of a candidate or a recommendation for a potential candidate are both welcome," he says.

Alumni should contact Harl P. Aldrich Jr., '47, in care of the Office of the Chancellor, Room 3-208, M.I.T.; at Haley and Aldrich, Inc., 238 Main St., Cambridge, 02139; or at 91 Rollingwood Lane, Concord, Mass., 01742, (617) 369-4420. Other search committee members will also welcome expressions of interest:

☐ Norman B. Leventhal, '38, General Partner, The Beacon Companies, One Center Plaza, Boston 02108 (617) 742-5500.

☐ Thomas H. Farquhar '60, Vice President, Massachusetts Financial Services, Inc., 200 Berkeley St., Boston 02116, (617) 423-3500.

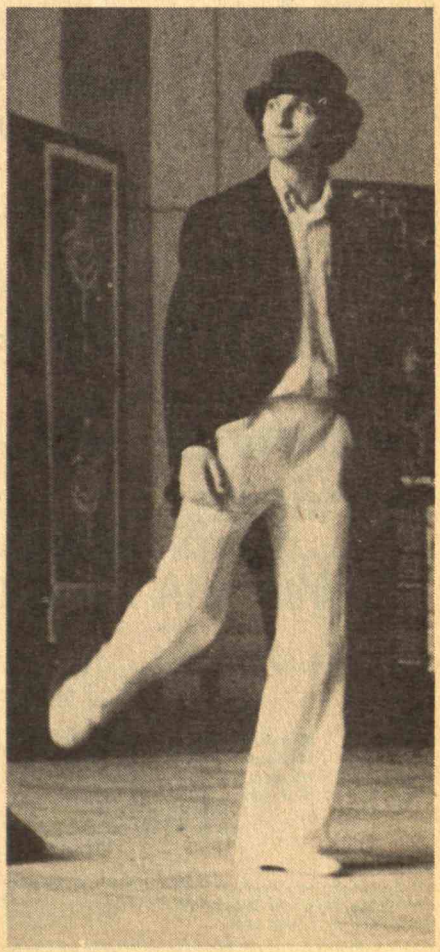
☐ Philip H. Peters, '37, John Hancock Mutual Life Insurance Co., Hancock Place, Boston 02117, (617) 421-6000.

☐ Emily L. Wick, '51, Dean of the Faculty, Mary Lyon Hall, Mount Holyoke College, South Hadley, Mass. 01075, (413) 536-8168.

☐ Breene M. Kerr, '51, H-K Corporation, City Center Building, Main St. and Broadway, Oklahoma City, Okla. 73102, (405) 232-0551.

☐ Sylvester J. Gates, '73, Lyman Laboratory of Physics, Harvard University, or Apt. 14, 16 Trowbridge St., Cambridge, Mass. 02139, (617) 661-1697.

*To relieve spring tension was his assignment. One rainy day in May, Stanley Alan Sherman, mime, juggler, and silent comic, stopped traffic in Lobby Seven. Some students, preoccupied with the onset of finals, bustled through the lobby unaware of Stanley nonchalantly at their heels, mimicking their distraction. Others were only too glad to participate as Stanley scooped them from their seats. (Photos: Susanne Fairclough)*



**Individuals Noteworthy**

*Honors at M.I.T.*

**Lawrence B. Anderson,** '30, Dean Emeritus of the School of Architecture and Planning, the Joint Award for Excellence in Architectural Education by the Association of Collegiate Schools of Architecture and the American Institute of Architects . . . **Hale Bradt** and **Walter H. G. Lewin,** both professors of physics, have received the Exceptional Scientific Achievement Medals from the National Aeronautics and Space Administration for their work on N.A.S.A.'s High Energy Astronomy Observatory satellite . . . **John M. Deutch,** '61, head of the Department of Chemistry, awarded an honorary doctor of science degree from Amherst College.

To **David Botstein,** Associate Professor of Genetics, the 1978 $2,000 Eli Lilly and Co. Award in Microbiology and Immunology . . . To **Harold J. Hanham,** Dean of the School of Humanities and Social Science, the 1978 John H. Jenkins Prize for Bibliography (for his book, *Bibliography of British History, 1851-1914*) . . . to **Ann M. Graybiel,** Associate Professor of Psychology and Brain Science, the 1978 Charles Judson Herrick Award of the American Association of Anatomists . . . to **Florence Keil Dokansky,** Assistant Rotch Librarian, a Council of Library Resources Fellowship for special studies in 1978-79 . . . to **Nicholas J. Grant,** Sc.D. '44, Abex Professor of Advanced Materials, a $5,000 unrestricted grant of the Jacob Wallenberg Foundation through the Royal Swedish Academy of Engineering Sciences . . . to **John M. Edmond,** Associate Professor of Oceanography, the James B. Macelwane Award of the American Geophysical Union.

**Laurence R. Young,** '57, Professor of Aeronautics and Astronautics, is President-Elect of the Biomedical Engineering Society; he'll serve as President in 1979-80. **Simon Foner,** Chief Scientist and Head of the Research Division at the Francis Bitter National Magnet Laboratory, is Chairman-Elect of the Solid State Division of the American Physical Society.

Nine pieces of graphic design, including work by **Ralph Coburn,** '47, **Jacqueline S. Casey,** and **Betsy Hacker** (all of the M.I.T. Design Services), were accepted for the 24th annual exhibition of the Art Directors Club of Boston.

**Robert I. Rotberg,** Professor of History and Political Science, is the author of *Black Heart: Gore-Browne and the Politics of Multiracial Zambia* (Berkeley: University of California Press) . . . *On Aesthetics in Science,* edited by **Judith Wechsler,** Fellow in the Center for Advanced Visual Studies, has been published by the M.I.T. Press.

**Sanford A. Miller,** Professor of Nutritional Biochemistry, is now Director of the Bureau of Foods of the Food and Drug Administration; he'll be on leave of absence from the Institute for the duration of his federal service.

**Henry M. Stommel,** Professor of Oceanography, receives the Rosenstiel Award in Oceanographic Science for 1977 from the American Association for the Advancement of Science for "outstanding achievement in oceanographic science with emphasis on the physics and chemistry of the water column and the atmosphere." . . . **Frank E. Perkins,** head of the Department of Civil Engineering, has been named chairman of the Federal Dam Safety Independent Review Panel . . . **Charles Stark Draper,** Institute Professor Emeritus and senior scientist of the Charles Stark Draper Laboratory, was given the National Space Club's prestigious Dr. Robert H. Goddard Memorial Trophy.

*Rising and Changing in the World of Business*

**Lawrence Gould,** '50, named Chairman of the board of directors, President and Chief Executive Officer of M/A-COM, Inc. (formerly Microwave Associates, Inc.) . . . **David G. Black,** '46, previously Research Corp.'s Regional Grants Director, elected Corporate Secretary and has assumed his new duties at the foundation's New York headquarters . . . **Robert J. Reilly,** '44, former Vice President and Treasurer, appointed Vice President of Finance of I.C.I. Americas, Inc. . . . **Thomas Howitt, Jr.,** '50, promoted from Manager of Manufacturing to Corporate Director, Energy and Environmental Control, Manufacturing and Engineering Division at Corning Glass Works.

Raytheon Co. appoints two consulting engineers, the highest professional, scientific and engineering level at the company: **George M. Walsh,** '60, in the Submarine Signal Division; **Edwin R. Hiller,** E. E. '56, in the Missile Systems Division . . . **Jon L. Ganger,** '50, Senior Vice President of Frank B. Hall and Co., the insurance brokers, has been elected a director . . . **Parker E. Marean III,** '66, forms a new marine design firm, Woodin and Marean, Inc.

**Daniel J. Holland,** '58, elected Chief Executive of the new Massachusetts Capital Resource Co. . . . **Jerry L. Robertson,** '65, appointed Engineering Manager of Unex Laboratories, Inc. . . . **Stewart A. Washburn,** '45, joins Folger and Co., the management consulting firm, as a vice president . . . **James A. Wolf,** '65, an officer in Booz Allen and Hamilton's Management Consulting Group, elected a vice president.

**Richard N. Carlson,** '56, elected Vice President of First East Savings Bank. Mr. Carlson joined the bank in September last year . . . **Wayne A. Stuart,** '59, named a senior vice president of Farm Credit Banks of Springfield, Mass. . . . **Ralph Turner,** '44, named vice president of engineering for Southworth, Inc. at Portland . . . **William H. Enders,** '50, formerly vice president of marketing, promoted to vice president and general manager for the International Division of Rockwell International's Admiral Group.

**John J. (Jay) Wetzel II,** SL '73, a staff engineer for engine emissions systems

since 1976, appointed Director of Quality Control of Pontiac Motor Division . . . **Cheryl A. Hutchins,** '72, named administrative assistant to the vice president of operations for Great Northern Paper Co. Ms. Hutchins joined the company in 1972 as a technologist in the research department . . . **A. John Esserian,** '50, most recently from Baird Atomic, appointed Director of Industrial Relations at Analogic Corp. . . . **David P. Vanderscoff,** '66, previously Vice President and Actuary with the Manhattan Life Insurance Co., elected President of Northern National Life Insurance Co.

**James E. Lydon,** '50, formerly vice president of Corporate Relations at Boston Edison Co., named a senior vice president. . . . **George A. Wallace,** '53, appointed from group vice president for manufacturing to corporate vice president for administration of Olin Corp. . . . **Christian A. Gimre, Jr.,** '58, appointed manager of engineering and manufacturing services for Plastic Beverage Operations of the Plastic Products Division of Owens-Illinois, Inc. Mr. Gimre most recently served as manager of the company's Television Products Division manufacturing plant . . . **Randolph Pike,** '78, named Executive Vice President of Pike Industries.

**Carl Lindemann, Jr.,** '44, appointed to vice president, programs, C.B.S. sports. He comes from N.B.C. sports . . . **Clinton H. Springer,** '45, regional field manager of Allendale Insurance, named a vice president . . . **Harold W. Miller,** '57, elected president and general manager of I.T.T. Defense Communications Division. He joined the company in 1964 . . . **John C. Avallon,** '48, appointed executive vice president of the G.T.E. lighting group and will become president of the group October 31.

**William H. Enders,** '50, most recently from Admiral International, appointed vice president of product planning and development for the G.T.E. consumer electronics group . . . **Walter J. Robbie,** '42, former president and chief executive officer of the Gorham Company, has joined Towle Silversmiths as vice president of corporate manufacturing . . . **Charles H. Ehlers,** '52, president of the Dewey and Almy chemical division of Grace and Co., has been named to the post of corporate vice-president . . . **A. H. Newcombe,** '51, named international sales manager for the process equipment division of Bird Machine Co.

**S. John Zuckernick,** '52, executive vice president of the Vermont Electric Power Co., elected president and chief operating officer . . . **Louis E. Stahl,** '36, promoted to chairman of Beatrice Foods Co.'s chemical division. He also serves as a corporate executive vice president . . . **Peter Sexton,** '65, former manager of new product development at Handy and Harman, promoted to manager of the industrial products division . . . **Harry J. Fitzpatrick,** '49, previously marketing vice president of the energy products division of Lear Siegler, Inc., named president of that division.

**Anthony E. Mirti,** '51, has joined Otis Elevator Co. as vice president for technology. He was formerly division vice president for operations-production of the Sikorsky Aircraft division of United Technologies . . . **John H. Cantlin,** '42, appointed executive vice president of Hudson Lock . . . **Harold H. Leach,** A.S. '70, former engineering manager, promoted to manager of Adams-Russell's antenna and microwave division. He is also a vice president of the company . . . **Carl N. Graf,** '51, named a sector executive and a member of the corporate executive office of W. R. Grace and Co. He was previously the group executive of the chemicals group.

*Counselors: Officers, Directors, Advisors*

**Henry A. Morss, Jr.,** Ph.D. '34, elected trustee of the corporation of the Woods Hole Oceanographic Institution . . . **G. Robert Keepin,** '47, of the Los Alamos Scientific Laboratory, elected national chairman of the Institute of Nuclear Materials Management . . . **H. Daniel Stage,** '53, assistant professor of business administration at Loyola Marymount University, appointed director of the university's graduate program in business administration . . . **J. Charles Forman,** '53, elected executive director of the American Institute of Chemical Engineers and appointed secretary of the organization by its governing body, the A.I.Ch.E. Council.

**Louis S. Thompson,** '63, named director of the Northeast Corridor Improvement Project . . . **Paul Levy,** '72, former deputy director of Massachusetts' energy policy office, named chairman of the Department of Public Utilities . . . **Alexander V. D'Arbeloff,** '49, co-founder and president of Teradyne, Inc., elected as a trustee of the New England Conservatory of Music.

**Barbara Feeney Powers,** '49, appointed principal of Champlain Valley Union High School . . . **Michael A. Rosner,** '60, named chief of medicine at Holyoke Hospital . . . **John R. Ehrenfeld,** '53, named chairman of the New England River Basins Commission.

*Kudos: Honors, Awards, Citations*

**Samuel Waldstein,** '47, co-recipient of R.C.A.'s David Sarnoff Award for outstanding technical achievement for "excellence of team effort in the production development of a handheld laser rangefinder." . . . **John H. MacMillan,** '50, vice president of Babcock and Wilcox's nuclear power generation division, elected a fellow of the American Nuclear Society . . . **Ronald A. Rohrer,** '60, professor and chairman of the department of electrical engineering at the University of Maine, the Frederick Emmons Terman Award as an outstanding young educator in his field . . . **Freeman D. Shepherd, Jr.,** '58, branch chief at Hansom A.F.B., the Charles E. Ryan Award for technical achievement.

*When Professor George B. Thomas started his last lecture in 18.03, Differential Equations, before his retirement last May 16, his students poured him a glass of champagne. Professor Thomas responded by toasting and thanking them – and by proceeding with his lecture plan. Fifteen minutes later he was interrupted again, when the Logarhythms — M.I.T.'s "barber shop" singers — came into the room singing "Baby Face." There was a standing ovation; the Logarhythms went on with "For He's a Jolly Good Fellow"; Professor Thomas tried to say some more thanks, but the words wouldn't quite come; so he raised his champagne glass one last time — and quickly slipped out the side door. (Photos: Calvin Campbell)*

*S. A. Luria*

**102 Retirements This Summer; "May the Sun Shine Warmly . . ."**

*May the road rise to meet you,*
*May the wind always be at your back,*
*May the sun shine on you warmly,*
*May God hold you in the palm of His hand.*

That Irish blessing was invoked by James R. Killian, Jr., '26, Honorary Chairman of the Corporation, as his wish for 102 men and women who retired from M.I.T. jobs in the middle of the summer. Together they represented over 2,000 years of service to the Institute and countless capabilities that must now be found elsewhere.

And their "caring for M.I.T.," said President Jerome B. Wiesner at the dinner honoring the retirees, had "helped to create one of the most caring, most humane environments in the world."

Included on the roster were nine members of the faculty — in President Wiesner's words "an extraordinarily distinguished group not only professionally but in terms of their concerns for the Institute, their communities, and the world in general":

☐ **William F. Bottiglia** came to M.I.T. in 1956 from Ripon College, where he was Chairman of the Department of Romance Languages and Literatures. He won recognition immediately as "a very popular and innovative teacher," in Dr. Wiesner's words, and for ten years beginning in 1964 was Head of the Department of Foreign Literature and Linguistics. Since concluding that assignment, Professor Bottiglia has been teaching industrial philosophy and contemporary American society in the Sloan School of Management.

☐ **William W. Buechner,** '35, taught physics at M.I.T. for 37 years ever since completing his doctorate in that field in 1939. His Institute career began with an association with Professor Robert J. Van de Graaff, whose name is given to a class of electrostatic machines for generating extreme high voltages, and Professor Buechner himself was builder and director of the last and largest such machine (8 million electron volts) built at M.I.T in 1951. He was Head of the Department of Physics from 1962 to 1966.

☐ **J. Harvey Evans** was supervising ship design in the Shipbuilding Division of Bethlehem Steel Co., Quincy, Mass., when M.I.T. called him to join the Department of Naval Architecture and Marine Engineering in 1947. Since then he's taught in the field of ocean engineering and ship structures, contributed to research in those fields and in computer-aided design, and served in many professional assignments, notably for the Society of Naval Architects and Marine Engineers.

☐ **Irving Kaplan,** one of the founding members of the Department of Nuclear Engineering, is a foremost nuclear reactor physicist. He had a leading role in creating the theory and later the practice of U.S. nuclear reactor design, and he's had a major part in developing curricula for teaching nuclear engineering throughout the U.S. More recently he's given special attention to the history of science and the relationships between technology and society, teaching in the School of Humanities' Technology Studies Program.

☐ **Alfred A. H. Keil,** a German-trained marine engineer, was Dean of the School of Engineering from 1971 to 1977 — a period when the School pioneered new research and teaching coupling traditional engineering with economics, political science, management, and law — in Dr. Wiesner's words, "a vital and extremely difficult task which consumed much of Dean Keil's time and energy." Professor Keil came to M.I.T. in 1966 to be Head of the Department of Naval Architecture and Marine Engineering, and he moved quickly to establish and develop a Sea Grant Program at the Institute.

☐ **Salvador E. Luria** shared the Nobel Prize for Medicine or Physiology in 1969 and holds countless other, lesser honors; but at M.I.T., says President Wiesner, he may be even more appreciated for "the work and inspiration (which) account in large measure for the extraordinary fluorishing of fundamental biology." Dr. Luria came to the U.S. from Italy in 1940 and to M.I.T. from Notre Dame in 1959; his first assignment here was to organize new teaching and research in microbiology. He was the founding Director of the Center for Cancer Research in 1972.

☐ **Kevin Lynch,** who studied under Frank Lloyd Wright before World War II and came to M.I.T. in 1948, is an authority on the theory of city form and on the perception of the city environment by those who live within it. He has taught in these fields, was Co-Director of a Rockefeller Foundation research project on the perceptual form of the city, has worked in the Joint Center for Urban Studies of Harvard and M.I.T., and has written widely honored books, including *What Time Is This Place?* (1972) and *Growing Up in Cities* (editor — 1977).

☐ **Charles A. Myers** has taught industrial relations at M.I.T. for 39 years, and the affection with which he's remembered by many students led to his appointment in 1967 as Sloan Fellows Professor of Man-

*C. A. Myers*

agement. When Professor Myers first joined the Industrial Relations Section it was part of the Department of Economics, and under those auspices he became its Director in 1948; 16 years later the Section moved into the Sloan School and Professor Myers took a joint appointment in economics and management. He's an expert in labor relations, mediation, and employment conditions.

☐ **George B. Thomas** has taught mathematics to countless M.I.T. undergraduates as a member of the faculty for 38 years. His book *Calculus and Analytic Geometry*, first published in 1949, is now in its fifth edition; and he's also the author of successful mathematics texts for high schools and for advanced college courses in statistics and probability. Professor Thomas' popularity as an undergraduate teacher is suggested by the events at his last lecture of the spring term (*see left*).

Also on the retirement list were four administrative officers leaving major responsibilities at the Institute:

☐ **Lawrence E. Beckley,** '42, Assistant Director of the Center for Space Research, has helped manage projects in aeronautical engineering and space science at the Institute ever since his graduation in that field (except for three years on military leave with the U.S. Navy during World War II).

☐ **Paul V. Cusick,** Vice President for Business and Fiscal Relations, was the senior officer responsible for operating business policies and procedures. At M.I.T. since 1944, he's a specialist in educational institutions' fiscal relations with government agencies in the sponsorship of research.

☐ **Robert J. Davis,** Director of the Office of Personnel Relations, came to the Institute as Director of Union Relations in 1957 after serving in a similar capacity at Lincoln Laboratory beginning in 1955. Earlier he had been Chief of the Industrial Labor Relations Branch of the Division of Organization and Personnel, Atomic Energy Commission.

☐ **Frederic W. Watress,** '41, joined the M.I.T. staff upon graduation in management to help manage construction of the supersonic wind tunnel (now Building W91, the Aerophysics Laboratory). He's been in the Office of the Treasurer since 1952, serving as Recording Secretary since 1959.

**George Philip Capen, 1891-1978**

George Philip Capen, '13, permanent Secretary-Treasurer of his Class who was active as well in other alumni affairs, died in Biddeford, Maine, on July 19; he was 87.

When he was retired in 1956 Mr. Capen was Superintendent of Maintenance at Boston Lying-In Hospital. As a resident of Canton, Mass., he had been Chairman of the Board of Selectmen, Chairman of the Town and of the Norfolk County Republican Committees, and a member of the Canton Rotary Club.

Mr. and Mrs. Capen moved to a retirement home in Biddeford in '71. Their partnership over the years resulted in a series of class communications unusual for their scope and regularity in *Technology Review;* Mrs. Capen will continue to serve as Secretary of the Class.

Mrs. Capen has suggested that gifts in Mr. Capen's memory be made to the M.I.T. Alumni Fund, designated for scholarships.

**Jacob Bikerman, 1899-1978**

Jacob Bikerman, who was Research Associate in Civil Engineering at M.I.T. from 1956 to 1964, died on June 11 in Cleveland following a heart attack; he was 79.

At the time of his death, Mr. Bikerman — a native of Russia — was Adjunct Professor of Chemical Engineering at Case Western Reserve University.

**Earl P. Stevenson, 1894-1978**

Earl P. Stevenson, S.M. '18, former President and Chairman of Arthur D. Little, Inc., who was active in M.I.T. affairs and those of its Alumni Association, died in Boston on June 28; he was 84.

Mr. Stevenson, a distinguished industrial chemist, joined Arthur D. Little, Inc., as Director of Research in 1919; he had been instructor in chemistry at M.I.T. from 1916 to 1918. Mr. Stevenson served on the Visiting Committee to the Department of Chemistry from 1936 to 1940, and he was Chairman of the Massachusetts Business and Industry Committee for M.I.T.'s Second Century Fund in the 1960s.

**Deceased**

*Edward G. Lee,* '07; February, 1978; 964 74th St., Marathon, Fla.
*Melville K. Weill,* '09; June 14, 1978; 6 East View Pl., Port Jervis, N.Y.
*Frank A. Baker,* '10; May 5, 1978; The Pine Run Community, 13 Katsura Ct., Doylestown, Penn.
*Leroy E. Briggs,* '10; July 14, 1978; 1851 Washington St., Braintree, Mass.
*Early C. Kilman,* '12; December, 1972; Onancock, Va.
*George Philip Capen,* '13; July 19, 1978; Granite Point Rd., Biddeford, Maine
*Werner T. Schaurte,* '14; July 25, 1978; 404 Lauvenburg, Neuss, Germany
*Roger Williams,* '14; February 23, 1978; Box

**M.I.T.'s First Cost Overrun: 180%**

Retirement is a time for retrospection — and Glenn P. Strehle, '58, Treasurer of the Institute, did just that in preparation for his remarks at a dinner honoring the 102 M.I.T. employees who retired this summer *(see left).* Among the fruits of his research:

☐ There's nothing new about cost overruns, and the Institute never was immune to them. The Rogers Building, M.I.T.'s first home in the Back Bay section of Boston, was estimated to cost $157,000; but when the bills were all in, the actual total was $283,000.

☐ The gifts from George Eastman which made possible construction of the new M.I.T. buildings in Cambridge in 1916 amounted to 6 per cent of the stock then outstanding in Eastman Kodak Co. If M.I.T. had held that stock instead of investing its proceeds in the new educational plant, its value would now exceed that of the entire present investment porfolio of the Institute.

☐ In 1938 Mr. Strehle's predecessor as Treasurer, Horace S. Ford, recorded in his annual report the purchase of 500 shares of stock in International Business Machines Corp. It may have seemed a risky investment then, but Mr. Ford was absolutely right: each of those shares has since then split into 150 shares, and every $1 in the original investment has now become $275.

When people talk to Mr. Strehle about the future, he recalls for them the advice of T. Coleman du Pont, '84, who was a member of the M.I.T. Corporation from 1906 to 1930: "Almost invariably I tell men to double the size of their plans," Mr. du Pont is said to have advised, "and almost invariably I regret that I did not double *that.*"

432, Buckingham, Penn.
*William H. Brackett,* '15; May, 1978; 163 Meetinghouse Rd., P.O. Box 1084, Duxbury, Mass.
*Raymond D. Gladding,* '15; April 6, 1978; 17533 Hibiscus, Fontanta, Calif.
*Peter Masucci,* '15; October 8, 1976; 233 Amosland Rd., Norwood, Penn.
*Noah W. Gokey,* '17; June 19, 1978; 1320 E. Bay Shore Dr., Virginia Beach, Va.
*Mrs. J. Raymond Ramsey,* May 19, 1978; 890 Ridgewood Dr., Apt. 203B, Plainfield, Ind.
*William F. Tuttle,* '17; July 14, 1978; 308 So. Main St., Middletown, Ohio
*Aksil P. Andersen,* '20; February 5, 1978; 91 Riverglade E. Hadley Rd., Amherst, Mass.
*Robert L. Sumwalt,* '20; January 24, 1978; 1718 Madison Rd., Columbia, S.C.
*Dayton T. Brown,* '21; June 20, 1978; 9 Knolls Ln., Manhasset, N.Y.
*Edouard N. Dube,* '21; June 30, 1978; 216 Woburn St., Reading, Mass.
*Sidney Senzer,* '21; December 25, 1977; 114 Lawn Terr., Mamaroneck, N.Y.
*A. Martin Feldstein,* '22; December 13, 1975; 43 Buckingham Dr., Albany, N.Y.
*George W. Heathman,* '22; July 5, 1978; 73 East Dixon Ave., Dayton, Ohio
*John C. Molinar,* '22; June 2, 1978; Randolph Hill Rd., Randolph, N.H.
*Albert P. Powell,* '22; October 9, 1977; Paradise Bay Trailer Pk., Box 27, Second St., Bradenton, Fla.
*Frederick W. Wiegand,* '22; March 15, 1978; P.O. Box 12652, San Antonio, Tex.
*Frederick A. Kinch,* '23; 1975; 8 Colt Rd., Summit, N.J.
*Robert P. Shaw,* '23; August 3, 1978; 19 Dummer St., Bath, Maine
*Randolph Frantz,* '24; June 4, 1978; 3203 Peakwood Dr. S.W., Roanoke, Va.
*William W. Sturdy,* '24; June 19, 1978; Box JJ, Truro, Mass.
*F. Coolidge Hastings, Jr.,* '25; May 28, 1978; 4141 Larkstone Ave., Orange, Calif.
*George F. O'Brien,* '25; June 3, 1978; 16536 Sunset Blvd., Pacific Palisades, Calif.
*Fisher H. Pearson,* '25; May 22, 1978; 351 North Ave., Weston, Mass.
*Richard W. Tryon,* '25; May 3, 1978; 29 Highlands Ave., Springfield, N.J.
*Ariel F. Horle,* '26; January 31, 1978; 3210 Polk Ave., El Paso, Tex.
*Nelson E. Howlett,* '26; July 26, 1975; 210 N. Main St., Raynham, Mass.
*David F. McGrath,* '26; May 14, 1978; Notre Dame Convalescent Home, West Rock Rd., Norwalk, Conn.
*Andrew Canzanelli,* '27; August 7, 1978; 9 Plaza Ln., Buzzards Bay, Mass.
*Robert K. Doten,* '27; 1973.
*Louis J. Kelly,* '28; September 12, 1975; 4029 Terra Granada, #1-A, Walnut Creek, Calif.
*Herman J. Behrens,* '29; January 16, 1978; 116 W. Clinton Ave., Tenafly, N.J.
*Harcourt C. Vernon,* '29; July 3, 1978; 103 Haverhill Ln., Wilmington, Del.
*Bernard Canter,* '30; June 4, 1978; 109 Wayne St., Springfield, Mass.
*Edward M. Jenkins,* '30; July 12, 1978; 60 Twin Oaks Rd., Bridgewater, N.J.
*Arthur E. Fitzgerald,* '31; July 1, 1978; 9 Smith Ave., Lexington, Mass.
*J. Firth Marquis,* '31; June 5, 1978; 600 Marian Ave., St. Charles, Ill.
*Arthur D. Jewell,* '32; February 8, 1978; 1807 Varnum St. N.W., Washington, D.C.
*Howard H. Langdon,* '33; January 14, 1978; The Commons, Macedon, N.Y.
*Edward L. Meehan,* '33; June 19, 1978; 5603 McLean Dr., Bethesda, Md.
*Stanley M. Bebler,* '34; May 28, 1978; 208 Pine St., Pass Christian, Miss.
*C. Bradford Dean,* '34; May 16, 1978; 184 Main St., Fort Palin, N.Y.
*Winston W. Ehrmann,* '34; June 20, 1978; 812 Summit Ave., Mt. Vernon, Iowa
*F. S. Ko,* '34; March 21, 1978; 27 Magazine Gap Rd., Hong Kong
*Samuel A. Rulon,* '34; June 1, 1978; 322 South St., Philadelphia, Penn.
*Charles T. Stewart,* '34; June 21, 1978; 910 Convers Ave., Zanesville, Ohio
*Robert S. Carr,* '35; June 24, 1978; Charlestown Rd., Hampton, N.J.
*Arthur Riehl,* '35; April 24, 1977; 4015 25th Ave. S., Seattle, Wash.
*Darrell A. Root,* '35; August 2, 1978; 118 Millpond, North Andover, Mass.
*Michael S. Cettei,* '38; November 11, 1977; P.O. Box 224, Woodstown, N.J.
*James B. Lampert,* '39; July 10, 1978; 60 Oak Rd., Concord, Mass.
*Walter C. Stoll,* '41; June 5, 1978; Tambre 3, Madrid, Spain
*Vincent Bashore,* '43; 1977.
*Walter A. Platt,* '50; February 23, 1978; 500 First St., Fairlawn, N.J.
*Arthur C. Savoth,* '50; May 1977.
*Oscar R. Falconi,* '51; April 18, 1978; 19010 Portos Dr., Saratoga, Calif.

1. *Each point on the contour generator $\Gamma_V$ projects to a different point on the contour $C_V$.*
2. *Nearby points on the contour $C_V$ arise from nearby points on the contour generator $\Gamma_V$.*
3. *The contour generator $\Gamma_V$ lies wholly in a single plane.*

The first and second restrictions say that each point on the contour of the image comes from one point on the surface (which is an assumption that facilitates the analysis but is not of fundamental importance), and that where the surface looks continuous in the image, it really is continuous in three dimensions. The third restriction is simply the demand that the difference between convex and concave contour segments reflects properties of the surface, rather than of the imaging process.

It turns out that the following theorem is true, and it is a result that we found very surprising.

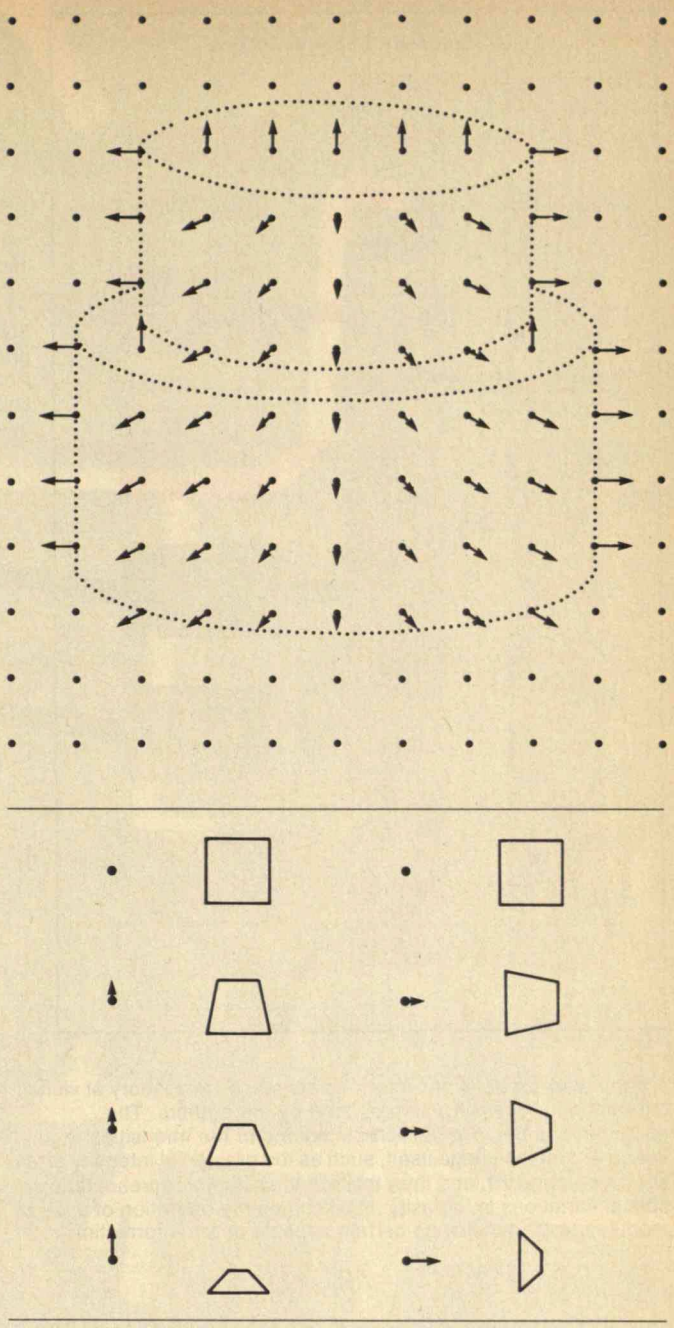
*Theorem. If the surface is smooth (for our purposes, if it is twice differentiable with continuous second derivitive) and if restrictions 1 through 3 hold for all distant viewing positions in any one plane, as illustrated on page 47, then the viewed surface is a generalized cone. The converse is also true: if the surface is a generalized cone, then conditions 1 through 3 will be found to be true.*

This means that if the convexities and concavities of a bounding contour in an image are actual properties of a surface, then that surface is a generalized cone or is composed of several such cones. In brief, the theorem says that a natural link exists between generalized cones and the imaging process itself. The combination of these two must mean, we think, that generalized cones will play an intimate role in the development of vision theory.

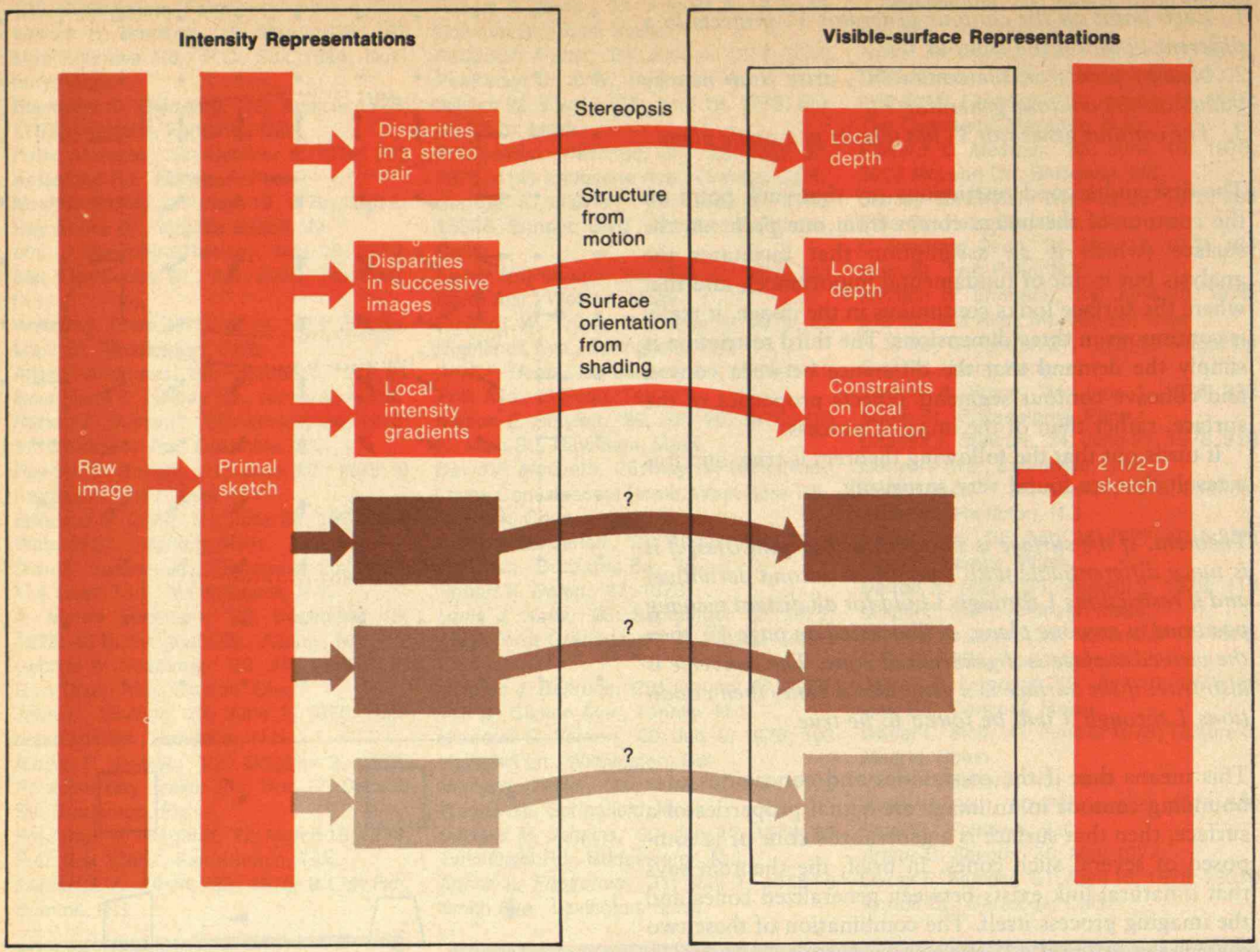
### The Search for a Theory

We have tried in this survey of visual information processing to make two principal points. The first is methodological: namely that it is important to be very clear about the nature of the understanding we seek. The results we try to achieve should be precise ones, at the level of what we call a computational theory. The critical act in formulating computational theories turns out to be the discovery of valid constraints on the way the world is structured — constraints that provide sufficient information to allow the processing to succeed. Consider stereopsis, which presupposes continuity and uniqueness in the world, or structure from visual motion, which presupposes rigidity, or shape from contour, which presupposes the three restrictions just discussed. The discovery of constraints that are valid and universal leads to results about vision that have the same quality of permanence as results in other branches of science.

The second point is that the critical issues for vision seem to us to revolve around the nature of the representations and the nature of the processes that create, maintain, and eventually interpret them. We have suggested an overall framework for visual information processing that includes three categories of representation upon which the processing is to operate. The first encompasses representations of intensity variations and their local geometry in the input to the visual system. One among these, the primal sketch, is expressly intended to be an efficient description of these variations which captures just that information required by the image analysis to follow. The second category encompasses the representations of visible surfaces — the descriptions, in other words, of the physical properties of the surfaces that



A candidate for the so-called 2½-dimensional sketch, which encompasses local determinations of the depth and orientation of surfaces in an image, as derived from processes that operate upon the primal sketch or some other representation of changes in gray-level intensity. The lengths of the needles represent the degree of tilt at various points in the surface; the orientations of the needles represent the directions of tilt — some examples are shown in the insert. Dotted lines show contours of surface discontinuity. No explicit representation of depth appears in this figure.

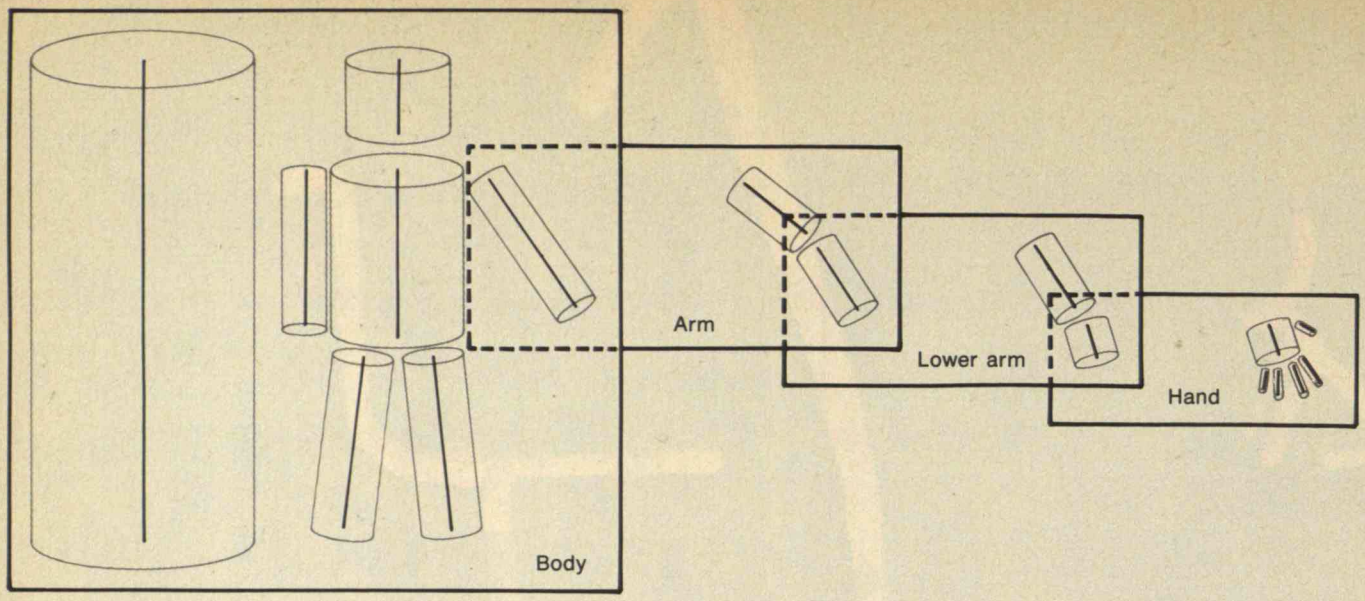



A framework for early and intermediate stages in a theory of visual information processing as proposed by the authors. The computations begin with representations of the intensities in an image — first the image itself, such as the gray-level intensity array shown on page 29, and then the primal sketch, a representation of spatial variations in intensity. Next comes the operation of a set of modules, each employing certain aspects of the information contained in the image to derive information about local orientation, local depth, and the boundaries of surfaces (Further details on the two uppermost modules are supplied in the text.) From this is constructed the so-called 2½-dimensional sketch, as shown on page 41. Note that no "higher-level" information is yet brought to bear: the computations proceed by utilizing only what is available in the image itself.

caused the images in the first place. The nature of these representations — the 2½-dimensional sketch in particular — is determined primarily by what information can be extracted by modules of image analysis such as stereopsis and structure from motion. Like the primal sketch of the previous category, the 2½-dimensional sketch is intended to be a final or output representation: this is where the separate contributions from the various image-analysis modules can be combined into a unified description. The third category encompasses all representations which are subsequently constructed from information contained in the 2½-D sketch. The designs of these tertiary representations are determined largely by the use to which they are to be put, as was the case for the 3-D model representation, to be used for shape recognition. If one had wanted instead, for example, to represent a shape simply for later *reproduction,* say by the milling of a block of metal, then the 2½-D sketch would itself have been sufficient, as the milling process depends explicitly on information about local depth and orientation, such as that sketch can provide.

We conclude with some observations on artificial intelligence in general. First a definition: "Artificial Intelligence" is (or ought to be) the study of information processing problems that characteristically have their roots in some aspect of biological information processing. The goal of the subject is to identify useful information processing problems, and give an abstract account of how to solve them. Such an account is essentially what we have been calling a computational theory — the uppermost of the four levels of understanding described at the outset of this article — and it corresponds to a theorem in mathematics. Once a computational theory has been discovered for solving a problem, the final stage is to develop algorithms that suit it. The choice of an algorithm usually depends upon the hardware available, and there may be many algorithms that implement the same computation. This is not to say that devising suitable algorithms will typically be easy once the computational theory is known, but it is to insist that before one can devise them, one has

The portrayal of animals by a small number of pipecleaners serves to show that the representation of a three-dimensional shape need not make explicit its surface in order to describe it so well that it can easily be recognized. The success of the representation is due, one suspects, in large measure to the correspondence between the pipecleaners and the axes of the volumes they describe.



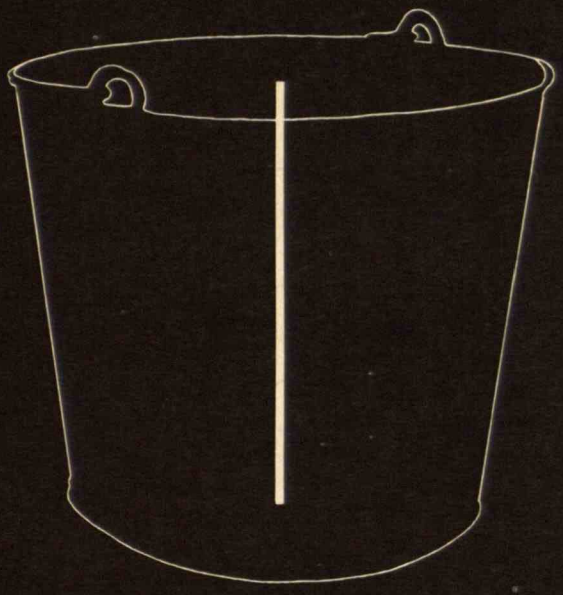

| | | Origin location | | | Part orientation | | |
|---|---|---|---|---|---|---|---|
| Shape | Part | $\rho$ | $r$ | $\theta$ | $i$ | $\phi$ | $s$ |
| Human | head | DE | AB | NN | NN | NN | AB |
| | arm | DE | CC | EE | SE | EE | BC |
| | arm | DE | CC | WW | SE | WW | BC |
| | torso | CC | AB | NN | NN | NN | BC |
| | leg | CC | CC | EE | SS | NN | CC |
| | leg | CC | CC | WW | SS | NN | CC |
| Arm | upper arm | AA | AA | NN | NN | NN | CC |
| | lower arm | CC | AA | AA | NE | NN | CC |
| Lower Arm | forearm | AA | AA | NN | NN | NN | DD |
| | hand | DD | AA | NN | NN | NN | BB |
| Hand | palm | AA | AA | NN | NN | NN | CC |
| | thumb | AA | BB | NN | NE | NN | BC |
| | finger | CC | BB | NN | NN | NN | CC |
| | finger | CC | AB | NN | NN | NN | CC |
| | finger | CC | AB | SS | NN | NN | CC |
| | finger | CC | BB | SS | NN | NN | CC |

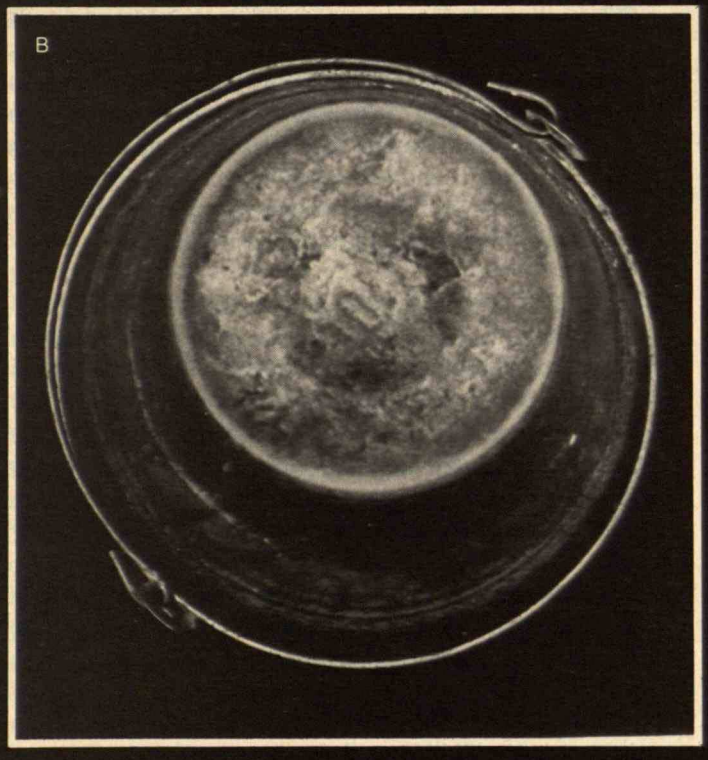
The arrangement of 3-D models into the representation of a human shape. First the overall form — the "body" — is given an axis. This yields an object-centered coordinate system which can then be used to specify the arrangement of the "arms," "legs," "torso," and "head." The position of each of these is specified by an axis of its own, which in turn serves to define a coordinate system for specifying the arrangement of further subsidiary parts. This gives us a hierarchy of 3-D models: we show it extending downward as far as the fingers. The shapes in the figure are drawn as if they were cylindrical, but that is purely for illustrative convenience: it is the axes alone that stand for the volumetric qualities of the shape, much as the pipecleaners on page 43 serve in themselves to describe the various animals. The illustration also includes a printout of the 3-D model representation as it is stored for use in a computer. The essence of the coding is to express how the various subsidiary axes relate to the shape as whole: where are they, which way are they pointing, and how long are they? For each of the modules, the first three quantities shown in the computer code specify the location of the proximal end of the axis: $\rho$ gives its position along the length of the axis of the overall shape, $r$ gives its distance outward therefrom, and $\theta$ gives the angle at which it is found. The last three quantities specify the orientation of the subsidiary axis. Two angles, $i$ and $\phi$, serve to give its direction, and a number, $s$, gives its length. In all cases, angles are specified by a set of compass directions, and lengths by a system of line-segment names; the details need not concern us. Note, however, that there is no *a priori* reason why this scheme ought to be favored; it is simply a possible way to describe a shape in a form that is volumetric, modular, and independent of vantage point.

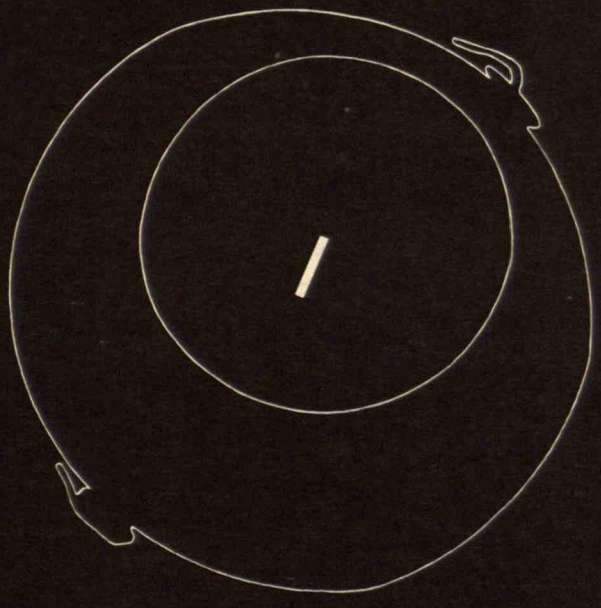
to know what exactly it is that they are supposed to be doing. When a problem in biological information processing decomposes in this way, we shall refer to it as having a *Type I* theory.

The fly in the ointment is that while many problems of biological information processing may turn out to have a Type I theory, there is no reason why all of them should. Consider in particular a problem that is solved by the simultaneous activity of a considerable number of processes *whose interaction is their own simplest description.* One possible example is the problem of predicting how a protein will fold, since it appears that a large number of influences act concurrently upon a large polypeptide chain as it flaps and flails in a medium. To be sure, only a few of the possible interactions will be important at any one moment, and any attempt to construct a simplified theory must ignore some of the conceivable interactions; but if most interactions are crucial at some stage during the folding, then the simplified theory will prove to be inadequate. As it happens, the most promising studies of protein folding are currently those that take a brute-force approach, setting up a rather detailed model of the amino acids, the geometry associated with their sequence, interactions with the circumambient fluid, random thermal perturbations, *etc.,* and letting the whole set of processes run until a stable configuration is achieved. We shall refer to such a situation as a *Type II* theory.

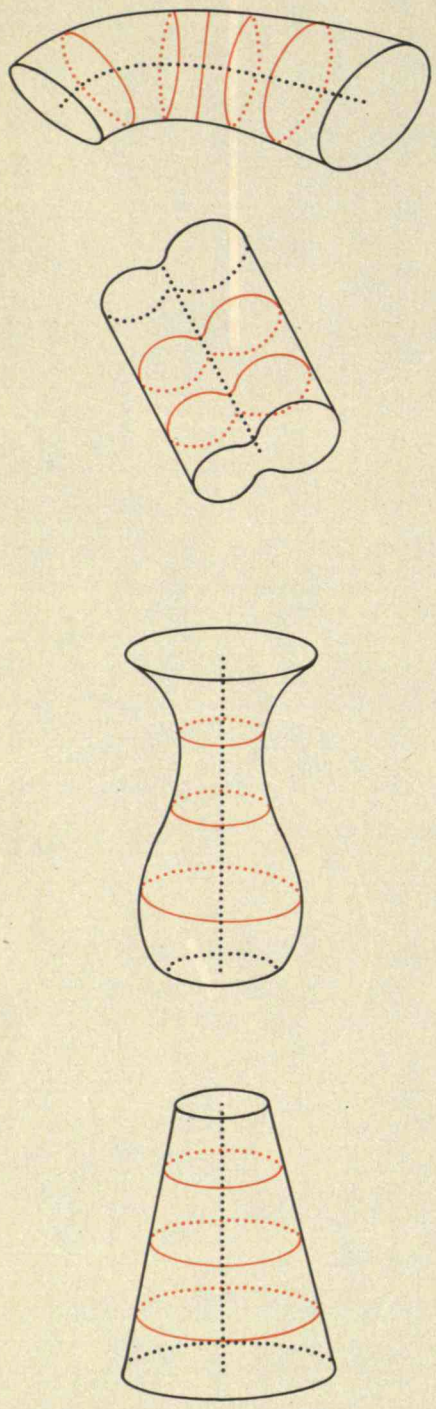
Now the principal difficulty in artificial intelligence is that one can never be quite sure whether a problem has a Type I solution. If one is found, well and good; but failure to find one does not mean that it does not exist. In particular, if one produces a large and clumsy set of processes that solves a problem, one cannot always be sure that there isn't a simple underlying computational theory whose formulation has somehow been lost in the fog. This danger is most acute in premature assaults on a high-level problem, for which few or none of the concepts that underlie its eventual decomposition into Type I



Two views of a water-pail. We display them because Warrington and Taylor reported in 1973 that patients with certain lesions in the right parietal lobe have difficulty in recognizing objects in views such as the one shown in (B). Consider, therefore, that the axis of the water-pail is directly recoverable from an image such as (A), but not from (B), where it is severely foreshortened, as shown by the line drawings that compose the right half of the figure. Consider also that in the 3-D model representation the recognition of a three-dimensional shape relies on the explicit representation of just such an axis. One thus is led by the theory itself to conclude that the recognition of views such as (B) will require considerably more computation than that required for (A).



The definition of a generalized cone. In this article, it is the surface created by moving a cross-section along a given straight axis. The cross-section may vary smoothly in size, but its shape remains constant. We here show several examples. In each, the cross-section is shown at several positions along the trajectory that spins out the construction.

theories have yet been developed, and one runs the risk of failing to formulate correctly the problems that in fact are involved. In the work of our own group, it first appeared, for example, that image analysis would require a Type II theory. But as more information came to light, we began to see how the analysis might decompose into separate modules for computing certain aspects of visual information — motion, stereoscopy, fluorescence, color — each one of *these* with a theory of Type I. After all, there is no reason why a single theory should encompass the whole. Indeed, one would *a priori* expect the opposite; that as evolution progresses, new modules come into existence that can cope with yet more aspects of the data, and as a result keep the animal alive in ever more widely ranging circumstances. The only important constraint is that the system as a whole should be roughly modular, so that new facilities can be added easily.

Yet even if there turns out to be a Type I theory, or a set of Type I theories, for the extraction of information from sensory data, there would still be no reason why that theory or theories should bear much relation to the theory of more central phenomena. In vision, for example, the theory that says 3-D representations are based on stick-figure coordinate systems and shows how to manipulate them is independent of the theory of the primal sketch, or for that matter of most other stages *en route* from the image to that representation. In short, it is dangerous to suppose that a theory of a peripheral process has any significance for higher level operations.

What, then, shall we say of intelligence? Many people in the field expect that, deep in the heart of our understanding, there will eventually lie at least one and probably several important principles about how to organize and represent knowledge that in some sense captures what is important about the *general* nature of our intellectual abilities. While still somewhat cloudy, the ideas that seem to be emerging are the following:

*1. That the "chunks" of related knowledge for reasoning, language, memory, or perception ought to be larger and have more flexibility in their structure than most recent theories in psychology have allowed.*
*2. That the perception of an object or of an event must include the simultaneous computation of several different descriptions — descriptions that capture diverse aspects of the use, purpose, or circumstances of the object or event.*
*3. That the various descriptions include coarse versions as well as fine ones; for the coarse descriptions are a vital link in establishing correctly the roles played by objects and events.*

An example will help to make these points clear. If one reads

*A. The fly buzzed irritatingly on the window-pane.*
*B. John picked up the newspaper.*

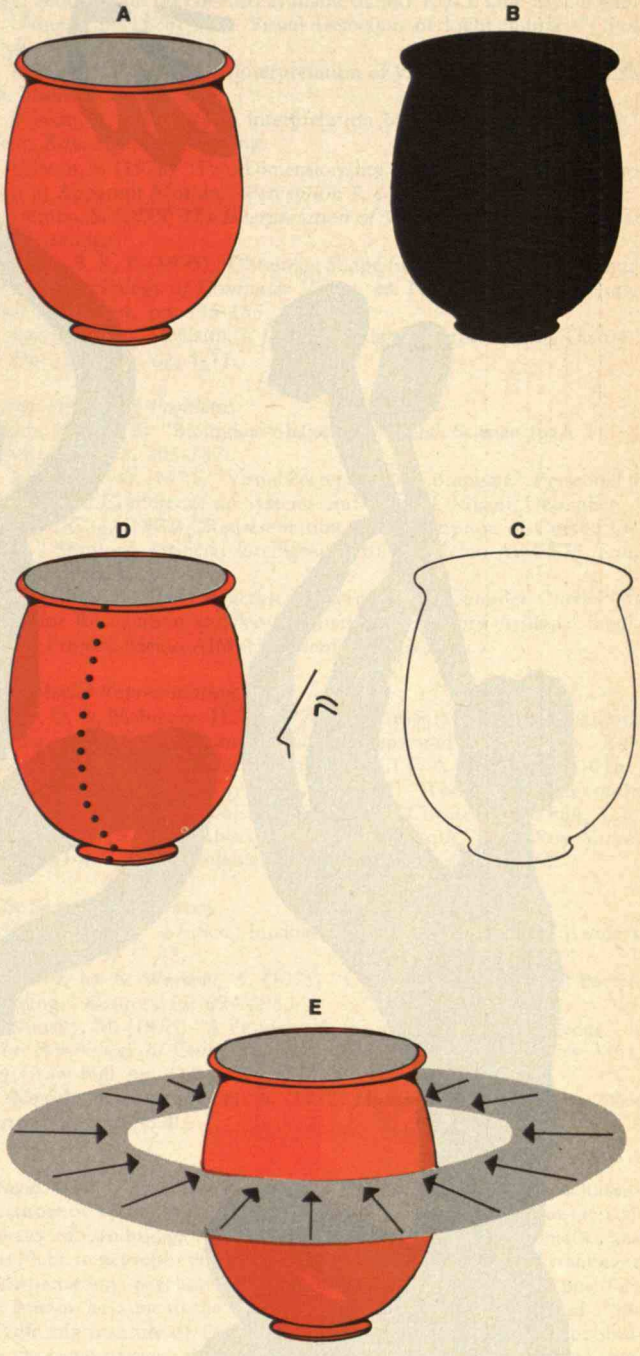
the immediate inference is that John's intentions towards the fly are fundamentally malicious. If he had picked up

the telephone, the inference would be less secure. It is generally agreed that an "insect-damaging" scenario is somehow deployed during the reading of these sentences, being suggested in its coarsest form by the fly buzzing irritatingly. Such a scenario will contain a reference to something that can squash an insect on a window's brittle surface — a description which fits a newspaper but not a hammer. We might therefore conclude that when the newspaper is mentioned (or in the case of vision, seen) not only is it described internally as a newspaper, and some rough 3-D description of its shape and axes set up; it also is described as a light, flexible object with area. Indeed, because sentence (B) might have continued with the words "and sat down to read," the newspaper may also be being described as reading-matter; similarly, as a combustible article, and so forth. It follows that most of the time, a given object or event will give rise to several different coarse internal descriptions. After all, one seldom knows in advance what aspect of an object or event is important. Notice that the description of fly-swatting or reading or fire-lighting does not have to be attached to the newspaper; merely that a description of the newspaper is available that will match its role in each scenario.

The importance of a primitive, coarse catalogue of objects and events lies in the role such coarse descriptions play in the ultimate construction of exquisitely tailored specific scenarios, rather in the way that a general 3-D model description of a shape — one in which only the first level in a hierarchy of stick axes has been specified — can be elaborated as further visual information becomes available to produce eventually a very specific interpretation. What after sentence (A) existed as little more than malicious intent towards the innocent fly becomes, with the additional information about the newspaper, a very specific case of fly-squashing.

Exactly what descriptions should accompany different words or perceived objects is not yet known. In fact, the problems to which we now are led have yet to be precisely formulated, let alone satisfactorily solved. But it seems certain that some problems of this kind do exist and are important; and it seems likely that a fairly respectable theory of them will eventually emerge.

One last observation. It sometimes happens that researchers postulate a particular mechanism or programming style as a central element of the human processor. They then use this mechanism to mimic some small aspect of human performance, for example by writing a language-understanding program, a problem-solving program, or an associative-memory program — each of these applicable only in a highly specialized domain. We believe that such studies are misguided, and the reason is this. If one believes that the aim of information-processing studies is to formulate and understand particular information-processing problems, then it is the structure of those problems that is central, not the mechanisms through which their solutions are implemented. Therefore, the first thing to do is to find operations that we as human beings perform well, fluently, reliably, and hence unconsciously, since it is difficult to see how reliability could be achieved if there were no sound underlying




Four structures of importance in studying the *a priori* conditions that we bring to bear on the analysis of a contour. Part (A) shows a three-dimensional surface, $\Sigma$. Part (B) shows its silhouette $S_V$ as seen from viewpoint V. Part (C) shows the contour $C_V$ of $S_V$. Part (D) shows the set of points $\Gamma$ that project onto the contour. A further part of the illustration shows a condition for a theorem discussed in the text. Here, in particular, the meaning of "all distant viewing directions that lie in a plane" is schematically shown.

computational theory. The next thing is to find out how to do them, and the next after that is to examine our performance in the light of our new understanding. In contrast to all this, current problem-solving research has tended to concentrate on problems that we understand well intellectually, but in fact *perform* poorly, such as mental arithmetic, in which one tries to add, multiply, *etc.* without aids such as pencil and paper; or crypt-arithmetic (for instance, DONALD plus GERALD equals ROBERT, where each letter stands for a digit whose identity is to be found). In other intances the research centers on theorem-proving in geometry or on games such as chess, in which human skills seem to rest on a huge base of knowledge and expertise. We argue that these are exceptionally good grounds for *not* studying how we carry out such tasks — at least not yet. There can be no doubt that when we do mental arithmetic we are doing *something* well, but it is not arithmetic, and we seem far from understanding even one component of what that something is. Let us therefore concentrate on the simpler problems first, for there we have some genuine hope of advancing.

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"Rites of Spring," by Pablo Picasso. We immediately interpret such silhouettes in terms of particular three-dimensional surfaces — this despite the paucity of information in the image itself. In order to do this, we plainly must unconsciously invoke certain a priori assumptions and constraints about the nature of the shapes. Further details are discussed in the text.


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# Automating Office Communications: The Policy Dilemmas

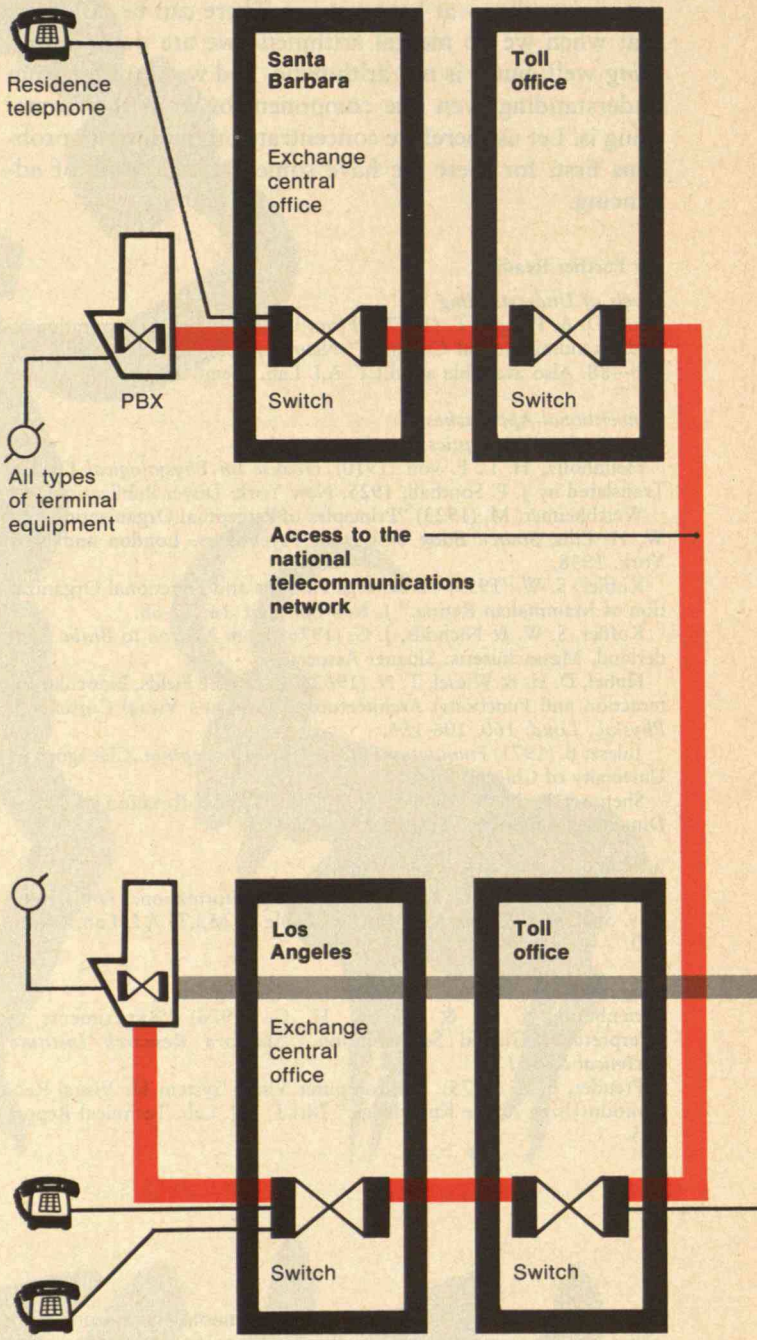
Marvin A. Sirbu, Jr.

Advances in computers and communications devices are transforming the office environment. The electric typewriter, the telephone and the copying machine, for years the only machinery white-collar knowledge workers could use to enhance their productive output, are making way for the individual computer terminal, the electronic message system, the laser printer and a host of other hardware and software for information handling and dissemination.

In the office of the future, each manager will have a personal small computer built into his desk and a high resolution video terminal next to the telephone. The terminal will enable the manager to send and receive mail, retrieve a file, access the company computer or the stock market ticker, prepare charts and tables, and do simple calculations. Within seconds paper copies of any document can be produced on the office copier. The company's telephone switchboard or Private Branch Exchange (PBX) will be run by a sophisticated computer which routes data, facsimile and voice throughout the building. It will also connect the company's internal communications to the public telephone network, to satellite circuits leased from R.C.A., Western Union or Satellite Business Systems (S.B.S. is a joint venture of IBM, Comsat and Aetna Insurance), and to the networks of several "value-added" carriers who supply communications augmented by various specialized services, such as error correction or statistical multiplexing. Decisions which formerly took weeks to make will be made in hours as electronic communications speeds the flow of vital information.

## Communications: Regulation and Competition

The revolution in computer technology, and the inexpensive microprocessor in particular, are the brainchildren of many small entrepreneurial firms competing openly in the best laissez-faire tradition. In contrast, the communications industry moves slowly in a strictured enviroment of




A nationwide telecommunications network allows a company which leases a private line from New York to Los Angeles to access the local exchange network via its Private Branch Exchange (PBX). Thus a call from the New York office to Santa Barbara uses the leased circuit for the cross-country portion of the call, and regular toll charges are incurred on the call only from Los Angeles to Santa Barbara.

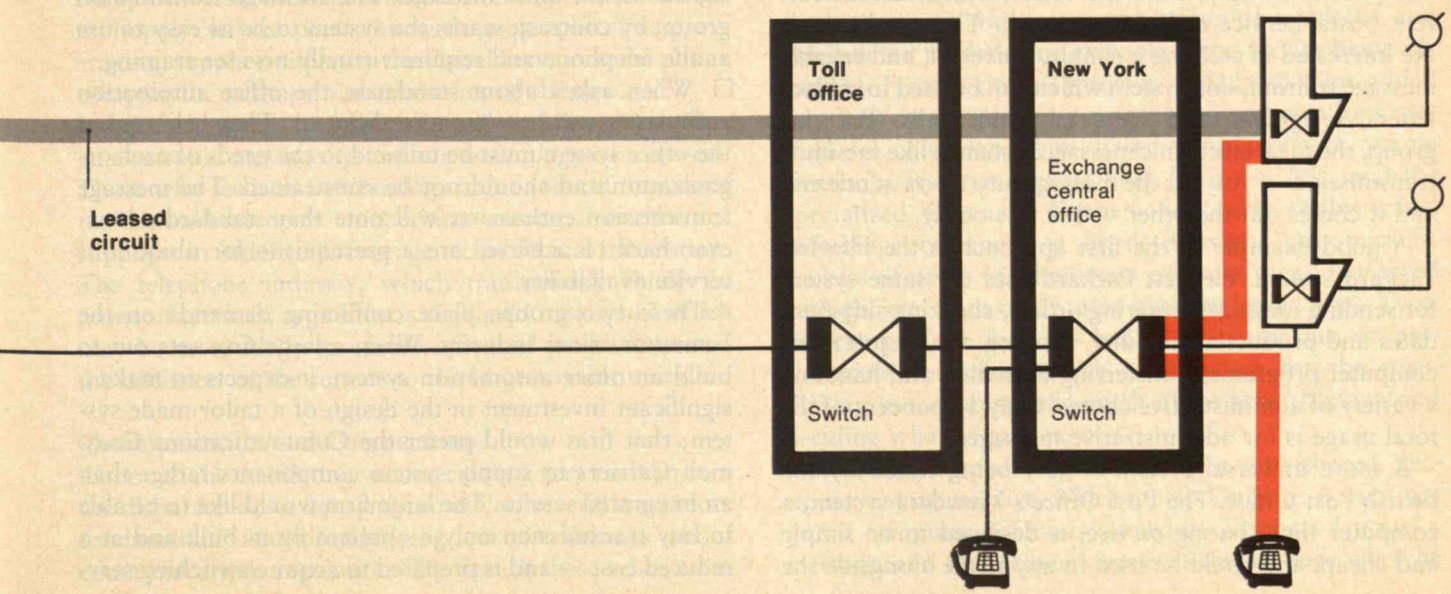
The combination of microprocessors and new communications techniques is opening new markets for office information systems. Now the F.C.C. and Congress must decide who can compete in these new markets, and how they should be regulated.

extensive regulation by state and federal agencies and international agreements. In this industry, regulation often determines which new services will be available, as well as who will provide them. Nevertheless, the last decade has seen the development of a host of new competitors who are challenging the traditional communications carriers. Using the latest technology, they have attacked the business communications market, offering new services and lower prices. Their success and the likelihood of continuing technological change has prompted a major reevaluation by Congress of the way the federal government regulates communications.

Two key decisions by the Federal Communications Commission in 1968 unleashed the fury of competition on a complacent telephone industry. Prior to 1968, A.T.& T. tariffs prohibited the direct attachment of any non-Bell equipment to telephone lines. Responding to a petition by the Carterphone Co., the F.C.C. overturned the tariff and ordered that the telephone companies permit the interconnection of any customer equipment — terminals, computers, switchboards — which does not interfere with the operation of the telephone network. Also in 1968 the F.C.C., ruling on an application by Microwave Communications Inc., authorized a new class of Specialized Common Carriers to compete with the telephone industry in the market for business communications. Microwave Communications, Inc., proposed to offer leased line service between Chicago and St. Louis at prices much less than A.T.&T.'s.

These two decisions created a vast new market, and literally hundreds of firms have rushed in to fill the breach. Computerized Private Branch Exchanges (PBXs), all digital communications networks, and burglar alarms which automatically telephone the police are but a few of the new products which have emerged as a result. More important, users are no longer limited to buying the services the telephone company has to offer. By leasing communication links and buying its own interconnection equipment, a user can set up a credit verification network or an order entry network or an electronic message system that suits its particular needs.

This new freedom brings with it a new set of problems which must be resolved. Consider for example the development of electronic mail or message systems (EMS). By EMS we mean transmitting text electronically from one terminal to another. Unlike the simple Telex network, an EMS may add a variety of additional capabilities such as the power to edit, store and retrieve messages, maintain distribution lists, and even incorporate graphs and charts along with the text. Hewlett Packard operates a worldwide electronic message system which costs less than 3 cents per message. Cook Industries, a grain exporter, uses EMS



to distribute critical information rapidly to their commodities traders. And this past summer A.T.&T. asked the F.C.C.'s permission to offer terminal to terminal communications as part of its new all-digital Advanced Communications Services system.

### Two Visions of Electronic Message Service

As yet, the development of EMS is in its early stages. Were the most innovative corporate systems now in use to be compared with the nearly 30 experimental university and private systems now under development, no universal approach to EMS would emerge. Each system is designed for a specific objective — low cost, or enhancement of user productivity, for example — and these objectives determine the characteristics of each system's design.

Taken as a whole, however, two widely differing paradigms divide the community of researchers and vendors developing electronic message systems.

Information — how it is stored, collected, communicated, and used — is the major concern of large user firms, academic researchers, and equipment manufacturers concerned with office functions. This group's primary objective is to automate administrative processing tasks, thus improving the productivity of both clerical and management personnel. To them, communication is simply one aspect of this complex range of information-related activities. And they design the message subsystem to serve and be integrated with larger office automation objectives.

On the other hand, the individuals and small firms, with the support of the communications industry and the postal service, see the primary goal of an electronic message system as moving text from one place to another, faster, more cheaply, and more conveniently than the current postal service or Telex network. These individuals are interested in creating a simple, universal, and reliable message transmission system which can be used to replace letters, telegrams, and some telephone calls. For this group, the ideal electronic message system is like facsimile transmission — you put the message into a box at one end and it comes out the other — but less costly.

A good example of the first approach is the Hewlett Packard system. Hewlett Packard uses the same system for sending messages, entering orders, checking shipment dates and product availability, running remote job entry computer programs, transferring data files, and handling a variety of administrative chores. Only 10 per cent of the total usage is for administrative messages.

A more universal system is now being tested by the British Post Office. The Post Office's Viewdata system, a computer time-sharing service, is designed to be simple and cheap, and could be used in any home alongside the TV set and the telephone. The Viewdata terminal uses an ordinary TV as a display and a telephone provides the link to a computer for information retrieval and message-switching. The only charge for the service is the cost of a phone call to the local exchange. To send a message, the user types in the text and supplies the Viewdata code number of the intended recipient, who then receives the message the next time he telephones the Viewdata computer. Or, the computer can call the recipient's telephone number, indicating with a special tone that a Viewdata message is to be sent. The recipient then turns on his TV terminal and receives the message. The system is not designed to do any kind of sophisticated word processing or office tasks — its use is limited to information retrieval and message switching.

These differences over the ultimate objective of the electronic message service manifest themselves in several significant ways:

- ☐ When asked what is the cost of an ordinary letter, the message transmission group will answer 15 cents. Those in the office automation group will answer four to six dollars. They will accept an equipment and communication charge of 50 cents to a dollar if there is a sufficient reduction in the labor costs associated with letter preparation and mailing. The message transmission group would like to use electronic mail to deliver mass computer-generated mailings where the cost is dominated by the price of a postage stamp.
- ☐ When asked about simplicity of use, the office automation group will talk about the ease of permitting several persons in different locations to edit the same message text simultaneously, or lightening the administrative load when the computer keeps track of who has been assigned action on a message. The message transmission group, by contrast, wants the system to be as easy to use as the telephone and require virtually no user training.
- ☐ When asked about standards, the office automation enthusiasts will be wary or indifferent. They believe that the office system must be tailored to the needs of each organization and should not be constrained. The message transmission enthusiasts will note that standards, however hard to achieve, are a prerequisite for ubiquitous service availability.

These two groups place conflicting demands on the communications industry. When a large firm sets out to build an office automation system, it expects to make a significant investment in the design of a tailor-made system; that firm would prefer the Communications Common Carriers to supply system components rather than an integrated service. The large firm would like to be able to buy transmission only — preferably in bulk and at a reduced cost — and is prepared to acquire switching serv-

ices elsewhere or provide them itself with its own hardware. The large user expects to select the specific system components and to assemble them in an architecture of its own choosing. The large firm can afford to deal with the Specialized Common Carriers even when there is a substantial initial charge for gaining access to their services — for example, the cost of a roof-top antenna in order to use a satellite channel. Finally, the large firm is willing and able to make the substantial capital investment necessary in order to build its own custom system.

The smaller firm and the individual user have neither the same needs or resources. These groups would prefer to link up to a message service which was complete from end to end. They want the simplicity and convenience of dealing with a single service vendor who takes complete responsibility for equipment, maintenance, and billing. The service should have a universal address space allowing them to communicate with whomever they choose. That the input and receipt of messages be as simple as dropping a letter in the corner mailbox is important; no specialized training for users should be required. The smaller firm and the individual cannot afford to make substantial investments in switching systems or terminals and would prefer a system with a very low entry cost and per-message charges.

The future structure of the communications industry is at stake in the conflict between the desires and needs of the large firm interested in office automation and the smaller firm and the individual interested in simple message transmission. The large firm generally endorses competition among communication common carriers: they support new carriers such as Satellite Business Systems or Microwave Communications, Inc. Conversely, cheap universal message transmission appears to call for monopoly service provision with geographical rate averaging, supplied either by the Postal Service or the phone company or perhaps a combination of the two.

Another way to look at this conflict is to ask whether an electronic message system is a *technology* or a *service.* Those who see it as a technology argue for a minimum of regulation and open competition among a number of suppliers in order to encourage technological innovation. The telephone industry, which traditionally thinks in terms of services, argues for a regulated monopoly which may be more likely to ensure universal penetration and the diffusion of the service to the largest community.

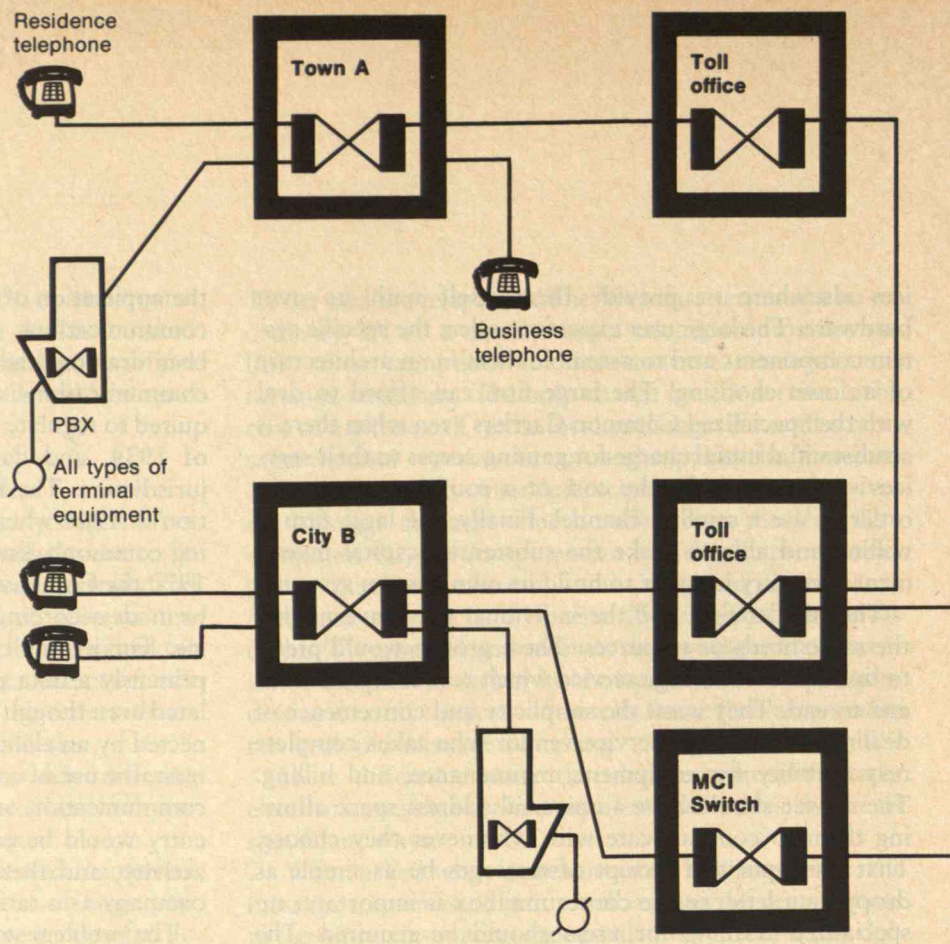
### Communication and Computation

Although the conflicting visions create a very real tension, the disparate views are symptomatic of several even more fundamental issues underlying current debates about communications regulation. The first of these arises from the application of digital electronics and the computer to communications. Since the mid-1960s the F.C.C. has been drawing and redrawing the boundary line between communications common carriage, which they are required to regulate under the Federal Communications Act of 1934, and data processing, which is outside their jurisdiction. The F.C.C. first began looking at this question in 1966 when they initiated a rule-making proceeding commonly known as the First Computer Inquiry. In 1970 the Commission tentatively proposed that decisions be made according to the predominant nature of the service. For example, time-shared computing, which was primarily a data processing activity, would not be regulated even though terminals and computers might be connected by an elaborate communications network. In contrast, the use of computers to provide, store, and forward communication or limited editing and buffering for data entry would be considered primarily a communications activity, and therefore could be offered by a regulated company as a tariffed service.

The problem with this definition is twofold. First, it is not always obvious what is predominantly communications and what is predominantly data processing. As a consequence, the F.C.C. has been required to make decisions in far too many individual cases. Furthermore, it has not been clear to potential service providers how the Commission will rule in any given instance. This uncertainty itself blocks the introduction of new services. Secondly, many new office communication services fall so squarely on the boundary that it is virtually impossible to make a consistent distinction between the two cases.

Turning again to our example of electronic message systems we see the uncertainties inherent in the present rules cooking up a smorgasbord of computer-based message services in various combinations of regulated and unregulated modes. One example is the service being offered by Tymnet Corp. Tymnet is a regulated value-added common carrier. It offers a packet communications network for connecting time-shared computers with remote terminals. It leases private lines from A.T.&T. and the Specialized Common Carriers and adds sophisticated switching computers to break messages into packets. Packets of up to 66 characters each are then interleaved with packets from other users over the leased lines. Tymnet charges not by time but on a per-packet or per-character-sent basis, which is attractive for the time-sharing user who spends much of his time thinking and deciding what to type next.

Recently, Tymnet began offering a time-shared electronic message service, which it calls Ontyme. A user logs into a computer, which is owned by Tymnet, deposits a message, and the recipient retrieves the message when he




Microwave Communications, Inc.'s Execunet service provides an alternative to A.T.&T. for long distance telephone calls. The caller dials a local number to gain access to the Microwave Communications, Inc. network, which routes the call first to the destination city and then over local lines to the message receiver.

logs in from his terminal. The entire service, including the processing associated with message preparation, storage and retrieval, is provided by the regulated carrier, Tymnet. It is, however, a bare-bones service. Tymnet does not supply text editing or formatting, and messages can only be retrieved by number, not by date or keyword. At the same time, Tymnet's parent firm, Tymshare, an unregulated time-sharing service bureau, has begun offering to the public a powerful electronic mail facility with features for editing, formatting, filing, sharing messages and data, etc. It is processing-intensive, and as such is being offered by Tymshare as an unregulated data processing service.

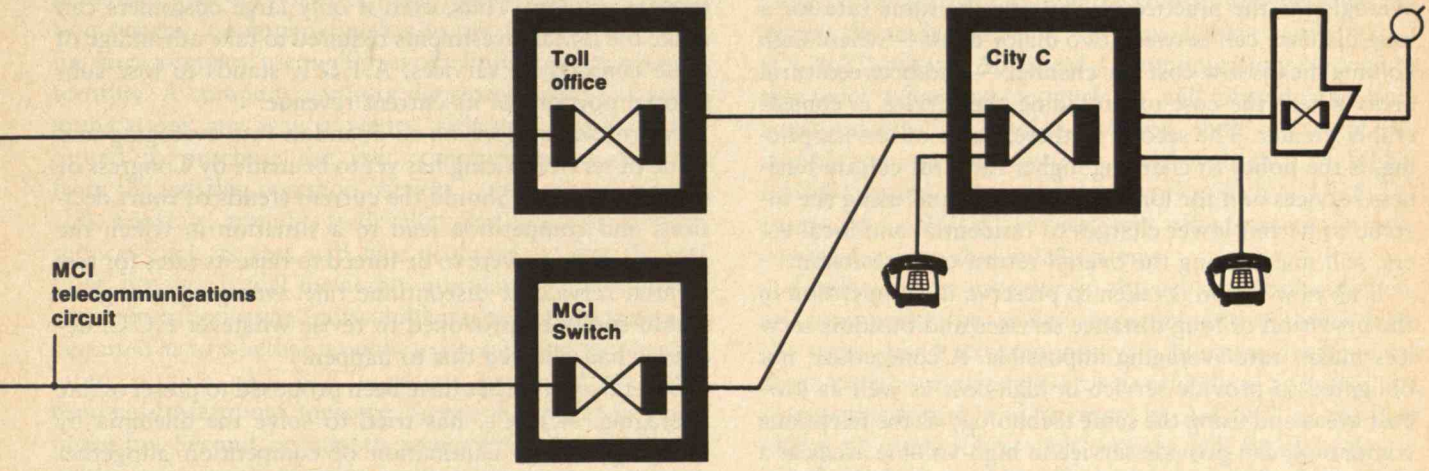
Scientific Time-Sharing Corp. recently proposed another configuration, offering a tariffed electronic message service using a computer and communications network that is primarily devoted to unregulated data processing. That is, the message service alone would be regulated, and all the other programs and all of the other equipment operated by Scientific Time-Sharing would be considered unregulated data processing. The difficulty raised by this alternative is resolving the question of how to allocate costs and profits between the regulated message offering and the unregulated data processing offering being provided with the same equipment.

The difficulties which the F.C.C. encountered in attempting to administer its decision in the First Computer Inquiry prompted it to re-open the question only six years later in 1976. In its Second Computer Inquiry the Commission proposed to eliminate the notion of hybrid communications or hybrid data processing. In its place the Commission proposed a rigorous functional breakdown in order to distinguish between processing which is ancillary to communication and unregulated data processing in general.

As expected, the data processing industry has protested that the new definition of regulated services would be too large, while the telephone industry fears that the rules would be far too restrictive. The issue is further complicated by the 1956 Anti-Trust Consent Decree against the Bell System, which prohibits A.T.&T. from engaging in the provision of any service which is not regulated. In other words, should the Commission decide that electronic mail service was to be provided on an unregulated, freely competitive basis, A.T.&T. would be prohibited at the outset by the Consent Decree from competing in that market.

Comments filed by different companies and trade associations in the Second Computer Inquiry were divided as to what should be done to change the regulations governing data processing and communication.

One group, including IBM and the Computer and Business Equipment Manufacturers Association, advocated regulation for pure transmission only. That is, the offering of a line in which you put bits or analogue signals in at one end and get them out exactly the same way at the other end would be regulated. Anything else — switching, call forwarding, editing, storage, retrieval, or anything that went beyond pure transmission — would be unregulated and could be offered by anyone. Notice that this conception argues in favor of the provision of




components of services rather than complete services. The large users who prefer to purchase the components that they need in order to tailor their own systems, without having to pay for a service which has been designed for universal application and may therefore contain features or restrictions unsuited for their needs, prefer this mode. Such regulation could lead to multiple suppliers of services and assumes that only transmission offers the economies of scale which justify regulation and monopoly provision.

By contrast, the Bell System and other existing carriers strongly favor regulation of services. That is, the entire service, the transfer of information for hire from point to point, which is the accepted definition of communication common carriage, and all ancillary activities necessary to accomplish that goal, ought to be provided by the common carrier.

### The Role of the Postal Service

No discussion of the transmission of communications would be complete without some reference to the role of the Post Office. The U.S. Postal Service is in the first stages of a multi-year project aimed at developing a system for electronic mail transmission that could handle as many as 30 billion pieces annually. The Postal Service currently operates a system with 42,000 local post offices and delivers to 80 million distinct address points. Any system that they design must be able to deliver to all those points and therefore will, certainly for the foreseeable future, provide for a majority of the messages to be printed out in hard copy at post offices and be hand-delivered in the manner of today's letters. Input may be from computer tapes or from scanning machines more widely located where an individual will take his letter, have it scanned by the machine, and then transmitted electronically to the post office nearest the destination for printing and final delivery.

The Postal Service is concerned for several reasons whether it should offer this service. First, there is a reluctance within the Postal Service to engage in competition in what has traditionally been the private sector activity of communications. On the other hand, they are also concerned with protecting postal revenues, and as they see more and more of their mail activities siphoned off by electronic funds transfer and other potential competitors, they may find themselves forced to switch to electronic message systems in order to avoid the need for even greater subsidies.

At present, the Postal Service does not have a monopoly for the carriage of electronic mail from terminal to terminal. Rather, the current postal monopoly extends only to the carriage of physical "letters" over "postal roads." Only an act of Congress can extend that monopoly to include terminal to terminal electronic mail service. And while the Post Office Committee in Congress might favor such action, because it is responsive to the demands of letter carriers and their unions, an equally vociferous objection would be expected to be raised within the House and Senate Subcommittees on Communications and their industrial supporters.

### Pricing Communications Services

The issue of pricing revolves around the problem of maintaining traditional social goals of redistributing costs among users by rate averaging and value of service pricing and, at the same time, encouraging competition which would stimulate new services and new technology. Rate averaging is the practice of charging the same rate for a long distance call between two major cities — where high volume means low cost per channel — and between rural areas where the cost of providing the service is considerably greater. The second of these, value of service pricing, is the policy of charging higher rates for certain business services and for long distance calls and using the income to permit lower charges to residential and local users, still maintaining the overall return on investment.

If no new action is taken to preserve it, competition in the provision of long distance services and business services makes rate averaging impossible. A competitor, not obligated to provide service in high-cost as well as low-cost areas and using the same technology as the telephone companies, can provide service in high-volume areas at a lower price than is currently being charged. Either business is lost to the competitor, or the phone company must lower its prices in order to meet the competition. In either case the surplus revenue previously earned on these high-volume routes would no longer be available for subsidizing communications between higher-cost rural areas.

In its initial venture into authorizing competition, the F.C.C. thought to limit it to private-line, business communications only. In fact it did not succeed in framing the regulations adequately to prevent Microwave Communications, Inc. from offering what is essentially a competitive *switched* long distance service, Execunet, to anyone who wished to subscribe. An Execunet customer dials a local number to gain access to the M.C.I. network. After entering an identification code, the customer dials his long distance call which is routed over the M.C.I. network to the local exchange, and then over telephone company lines to the final destination — only for the local part of the call, long distance connections being supplied by M.C.I. The F.C.C. has now been forced by the courts to decide whether long distance communications, a monopoly service provided by the Long Lines Division of A.T.&T., should be a competitive service available from any number of companies.

However, even if the Commission had succeeded in what it believed to be its original intent, to limit competition to fixed leased line service, the ability of modern PBXs to route a call coming in over a leased line out through the public switched network to another location means, for example, that a corporation can lease a line from New York to Los Angeles and then make all its calls in the Los Angeles area as if they were local calls. By such means the large user can almost totally bypass the long distance switched telephone network. In 1975, the telephone industry's 100 largest corporate customers accounted for 20 per cent of the Bell System's total revenues for interstate services. Thus, even if only large customers can make the initial investments required to take advantage of these competitive services, A.T.&T. stands to lose substantial portions of its current revenue.

A firm social decision to abandon rate averaging and value of service pricing has yet to be made by Congress or the Commission. Should the current trends of court decisions and competition lead to a situation in which the phone company were to be forced to raise its rates for residential service or discontinue rate averaging, Congress would surely be provoked to revise whatever F.C.C. decisions had allowed this to happen.

Several approaches have been proposed to preserve rate averaging. A.T.&T. has tried to solve the dilemma by lobbying for the elimination of competition altogether through such devices as the Consumer Communications Reform Act (also known as the Bell bill). There are alternatives. For example, legislation recently introduced by the House Subcommittee on Communications (H.R. 13015) would explicitly tax the competitive suppliers of private-line and long-distance communications service to provide the revenue for subsidizing rural services and residential services — the same procedure the telephone industry is now using internally. Such a tax would surely weaken the advantage the competitive carriers now enjoy which results from their charging on a cost basis in high volume areas, while the phone company continues to set its prices in order to generate a surplus for subsidizing higher cost or higher social value services. Whatever solution is adopted is likely to change the present advantage which the competitive suppliers have over A.T.&T. in the offering of private line services. This is not to say that they might not continue to have lower prices than A.T.&T. by virtue of superior technological innovation, but that much of the present advantage, which arises from what is called cream-skimming, would disappear.

The problem posed here in terms of telephone service also arises when one considers whether there should be rate averaging in a universal electronic message service. If electronic message service is allowed to develop piecemeal with competitive suppliers, rural and small users will undoubtedly pay substantially higher costs per message than their larger urban counterparts. An EMS restricted to a single monopoly supplier would allow rate averaging to be practiced in much the same way as it is now by the Bell System and the Post Office.

### The Future of Office Communications

What does all of this mean for the future evolution of office communication? First of all, the only aspect of communication which we regulate today is common carriage, that is the conveying of information from one place to another *for hire*. Whatever *private* communication network or services or electronic mail system, or transaction system, a company wishes to put together for itself for intracompany use, will provoke little or no regulatory scrutiny. A company can mix data processing and communications any way it wants, although it may be required to purchase the raw communications capacity from the existing common carriers.

By contrast, attempts to develop new *common carriage* services such as EMS will face obstacles on two fronts. First, because it will inevitably mix data processing and communication in an indissoluble fashion, questions will be raised as to whether it ought to be regulated or unregulated service. A.T.&T.'s recent proposal to offer terminal-to-terminal message service has already come under fire. Second, because the issue of how to achieve the public policy goals of uniform rates and universal service while permitting competition remains unsettled, offerers face the possibility that the rules governing competition will be changed after the service has been initiated, and that they will find themselves in a very different environment with respect to prices and availability of communications channels or other components of their service. Unregulated firms will hesitate to offer service for fear of coming under regulation. Regulated firms will limit the amount of processing for fear of being required to set up a separate subsidiary.

Second, as a result of the Carterphone decision in 1968, users are free to attach a wide range of devices directly to their telephone line. The ubiquity of the public switched telephone network suggests that office communication systems which connect directly to the phone network, such as facsimile machines and communicating word processors, will continue to enjoy favor especially for communications between firms. Protocols are also being developed by several groups that would enable the voice telephone network to be used for establishing contact between two corporate computer systems. The use of the regular telephone network for sending data is an accepted practice in the U.S. In some foreign countries, however, sending data over the public voice network is still prohibited.

Third, companies with mutually intelligible private electronic message systems may be able to communicate with each other through a simple communications channel, if they can agree on common protocols. Already we have the development of the internationally approved X.25 protocol for packet communications networks, which provides a basis for error correcting digital transmission between two nodes in a network. These protocols, together with higher level standards such as the standard for message headers developed by M.I.T. and others for the Advanced Research Projects Agency of the Defense Department, will allow transfers of messages between dissimilar message systems. Packet networks — A.T.&T.'s digital Advanced Communications Service or the voice telephone network — will provide the pure transmission link needed between these privately designed and operated systems. In the absence of higher level protocols, value added networks, such as I.T.&T.'s proposed COMPAC service, will offer conversion processing between dissimilar systems.

Finally, for the moment, in the debate over fundamental communication policy, pro-competitive forces have the upper hand. No monopoly in business communications systems or message services is likely to appear in the foreseeable future, and attempts by A.T.&T. or the Post Office to monopolize such services will be strongly resisted. However, a consequence of this competition is the subversion of the current practice of rate averaging and value of service pricing. When and if residences and rural users begin feeling the impact — for example, metered rates for local calls, or substantial increases in residential or rural rates — then we can expect Congress to act to develop new mechanisms for preserving equitable rates. These mechanisms in turn may cause a substantial alteration of the current competitive equilibrium between the Bell System and its competitors.

**Suggested Readings**

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# OTEC: Electricity from the Ocean

William F. Whitmore

The surface waters of equatorial oceans soak up solar heat like a giant sponge. Massive ocean thermal energy conversion plants may be turning this heat to usable electricity by 1985.

In the tropics, the oceans store an immense amount of energy from the sun. The band of surface water within 10° of the equator basks around at 80° F., while cold regions 3,000 ft. below are around 40° F. Ocean Thermal Energy Conversion (OTEC) uses this thermal gradient, like the hot and cold terminals of a gas turbine, to generate electricity. The essence of the system is the circulation of a fluid such as ammonia or propane. Where it comes near the warm water it is brought to a boil and so expands; where it comes near the cold, it liquefies once again. In the course of its circulation from one place to another, it drives a power-generating turbine. A typical closed-loop system would include two exchangers (evaporator and condenser), a turbine, and a generator.

### Fulfilling a Century-Long Promise

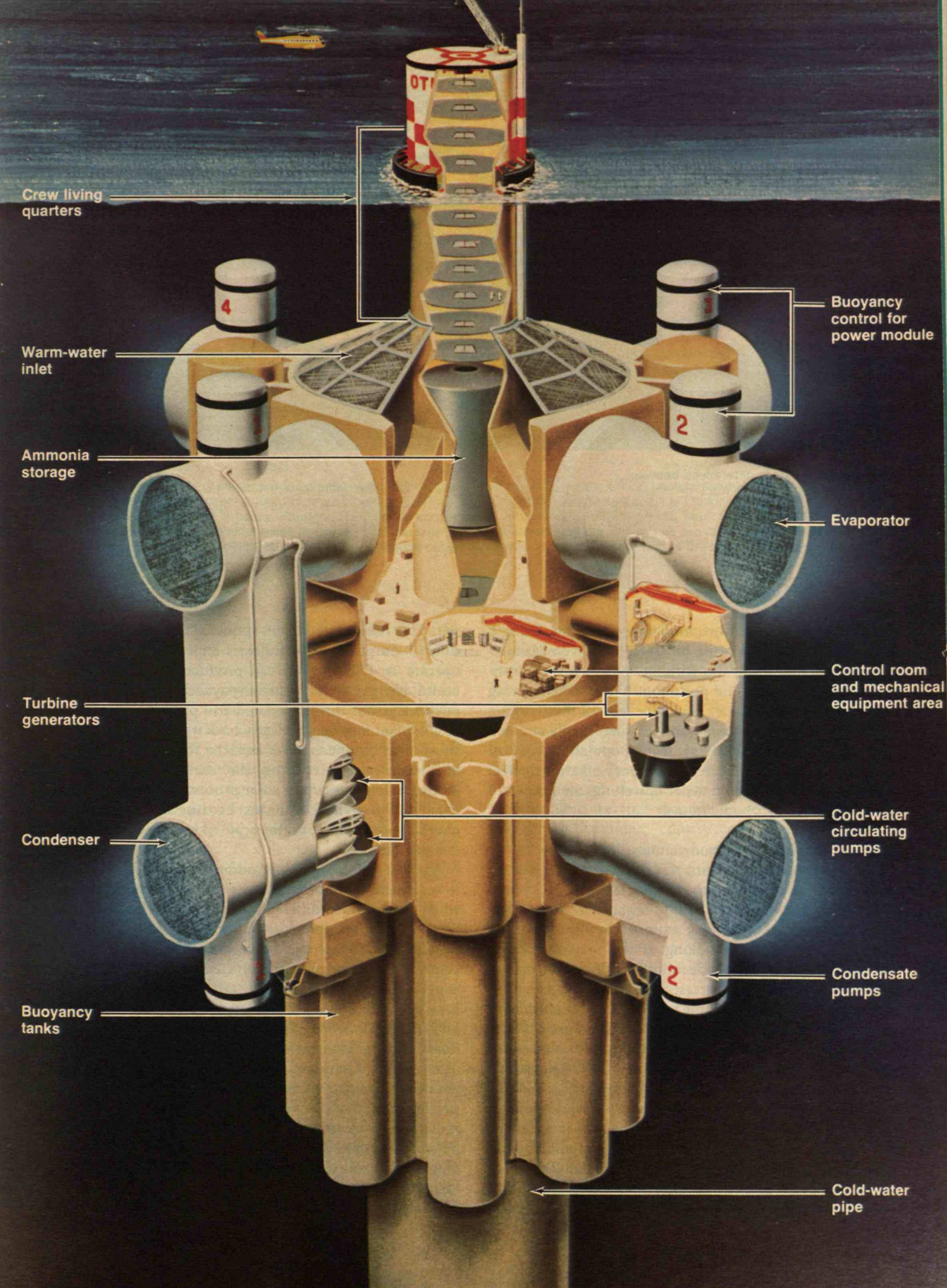
The idea of skimming energy from the ocean has been around since Jacques d'Arsonval considered its potential in 1881. French scientist Georges Claude actually operated a prototype ocean power plant off the coast of Cuba in 1930. He used an open-cycle design in which sea water itself provided the working fluid for the turbines. This primitive plant generated a 22 kilowatt gross power output before the cold water pipe was destroyed by a Carribean hurricane, exhausting his capital resources. A major technical problem he encountered in this open-cycle system was from the very low vapor pressure of sea water at ambient temperatures.

OTEC was revived in the 1970s, when the Middle East oil boycott sharpened the need to develop alternate energy sources. The National Science Foundation (N.S.F.) financed two academic research programs (at the University of Massachusetts and at Carnegie-Mellon University) for the design of large-scale OTEC plants. The "Mark II," a 400-megawatt plant design from the University of Massachusetts, housed the turbines and condensers in concrete hulls 183 meters long which balance like a submerged catamaran. This plant was to be tethered off the coast of Miami, and an undersea cable would take its power to shore. The Carnegie-Mellon version was to be fully automated and unmanned. A plant investigated by the Applied Physics Laboratory at Johns Hopkins University features condensing units in small modules for easy removal during periodic servicing and cleaning. Grazing at 0.5 knot in the mild environment found along the equator, it was designed for maximum efficiency to stay within the zones of warmest surface temperatures which move about with seasonal changes.

In the spring of 1974, N.S.F. solicited industry for a detailed engineering and economic analysis of a baseline OTEC plant that could generate power at a cost competitive with oil-fired plants. Parallel contracts were awarded to Lockheed Missiles and Space Co. and to TRW, Inc., who reported their results in the spring of 1975. Each study concluded that OTEC plants on the scale of 250 megawatts were technically feasible and were capable of delivering electric power at a cost about equal to that of plants fired with oil at $12 a barrel. Fairly modest improvements to the baseline design could lead to fully competitive OTEC commercial plants as early as 1985. The initial contribution to the U.S. energy demand would be minute, but it could grow to a few per cent of the total U.S. requirement by the year 2000, adding a useful increment to the goal of energy self-sufficiency. Support of the OTEC program is now in the hands of the Department of Energy, which has been allotted $34 million of the 1978 federal energy budget. D.O.E. is vigorously pursuing component technology studies and hardware demonstrations related to OTEC. A component demonstration contract at the one-megawatt level is being awarded this year, with larger-scale efforts following close behind.

Why is OTEC alluring? Because it uses the ocean as a heat sink, which stores energy day and night. Unlike the more publicized solar collecting units, it can provide utilities with "baseload capability" on line 24 hours a day. It can economically generate power at a level of 250 mega-

A leading design for an OTEC plant is this vertical, semi-submerged spar-shaped structure — comparable in size to off-shore oil plants. Its configuration makes it insensitive to wind and wave turbulence. Held in place by a single mooring line and weight anchor in tropical oceans, its electrical power would be taken to shore by cable. Two crews of about 30 persons each would be required to operate an OTEC plant. Power from the first commercial OTEC plant is expected by 1986. (Drawing: Lockheed Space and Missile Co., Inc.)


Crew living quarters
Warm-water inlet
Ammonia storage
Turbine generators
Condenser
Buoyancy tanks
Buoyancy control for power module
Evaporator
Control room and mechanical equipment area
Cold-water circulating pumps
Condensate pumps
Cold-water pipe
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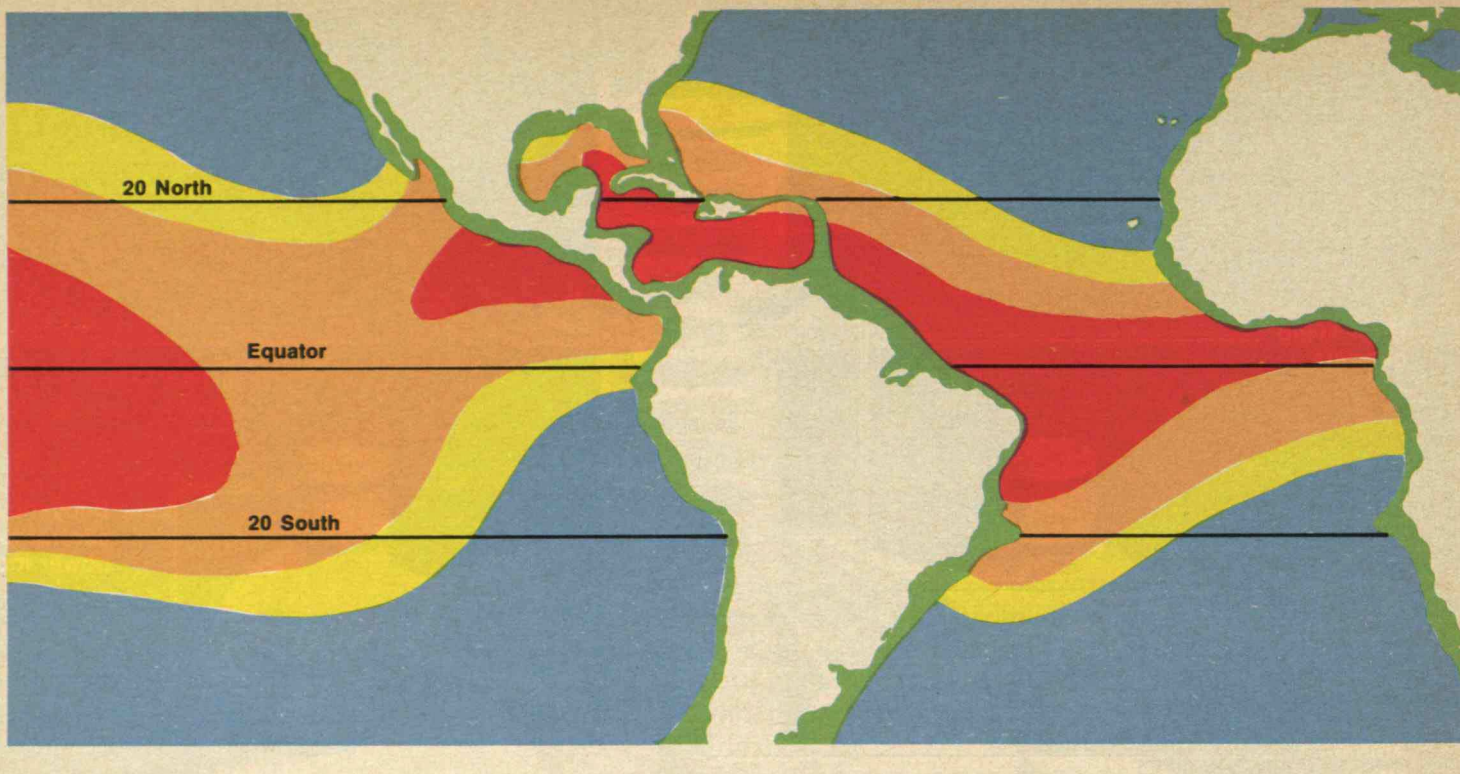



Average temperature differences between surface and 3,000 feet depth:
- Less than 32°F
- From 32°F to 36°F
- From 36°F to 40°F
- Over 40°F
- Water depth less than 3,000 feet

watts and up, enough for a moderate-sized city. Using a renewable resource, the sun, its "fuel" is delivered directly to the site in usable form without charge. It is environmentally benign, emits no poisonous byproducts (barring the remote contingency of a massive leak of the working fluid — probably ammonia), and it is necessarily situated unobtrusively offshore, away from population centers. All evidence to date indicates that it has no harmful effect on ocean life; indeed, cold water upwellings are known to be beneficial to fish populations.

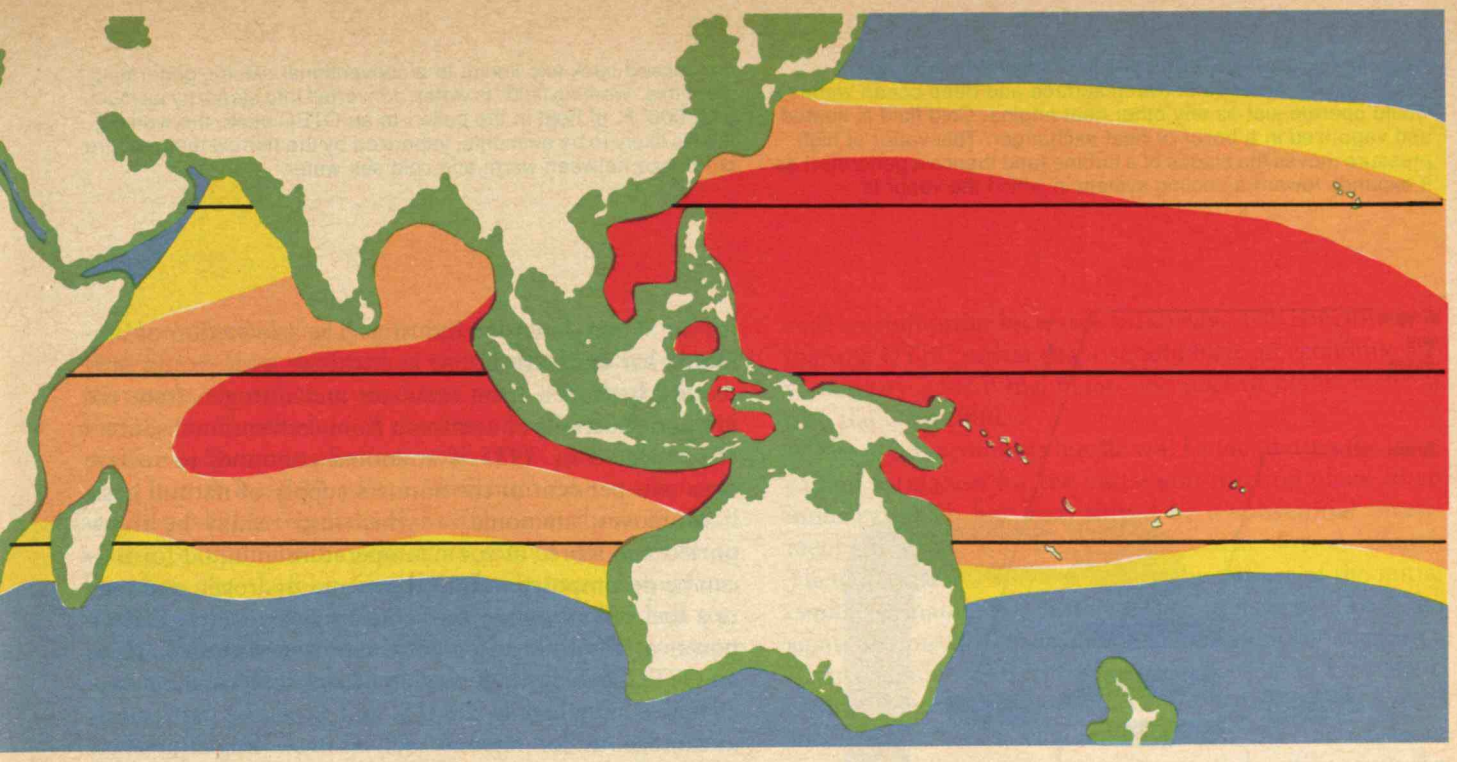
### Oddities of OTEC Thermodynamics

A general argument favoring OTEC is the "net energy assessment," pioneered by the State of Oregon. It is based on the fact that energy must be "organized" to be used and that the act of organizing requires the expenditure of energy — one way of looking at the Second Law of Thermodynamics. To produce 1000 calories of energy from more traditional sources, a fossil-fuel or a nuclear fission plant must be built, the fuel mined and refined and then transported to the site where it will be used. When all these energy "costs" are added up, 3,000 calories are usually expended to make available the 1,000 calories for useful work as output from the utility plant.

An OTEC plant, on the other hand, derives its energy from a natural and uncontrollable nuclear fusion plant — the sun. Solar energy is supplied directly to the site, at no cost, by radiation. Thus, over a nominal life of 40 years or more, the only energy "investment" for OTEC is the construction, deployment, and operation of the plant itself. This is estimated to be about 700 calories for 1,000 calories output. So 700 calories expended to build and operate an OTEC plant can produce 1,000 calories of useful energy — a positive payback. Note that this payback is not directly related to "profit" — a nuclear fission plant may very well pay back its monetary cost in a short time, but it can never beat the Second Law of Thermodynamics by reducing the entropy of the thermodynamic process. The solar processes manage to do so locally (as do living organisms) because the sun is outside man's control and is, on the scale of human existence, inexhaustible.

Another thermodynamic oddity of OTEC is its very low efficiency of about 2.5 per cent, resulting from the small temperature difference between the hot and cold terminals. In the conventional approach to analyzing a heat engine, this would be regarded (and has been, by some critics) as hopelessly inefficient. But since the fuel is supplied without cost, the only effect of the low efficiency is on the size of the heat exchangers and on the choice of working fluid. Ammonia turns out to be the best working fluid from the point of view of heat transfer, being twice as effective as propane, the next best candidate. Though ammonia has a number of unpleasant properties (it is poisonous and attacks copper pipe), it is no stranger to industrial operations. The mainstay of refrigerating plants 50 years ago (before the freons were developed), ammonia is still used in some refrigeration applications, including tuna boats.

Analyses sponsored by D.O.E. have shown that a



The prime sites for OTEC plants are in latitudes within 20° of the equator where surface temperatures range as much as 40° F. warmer than waters 3,000 ft. below. Though OTEC power can be generated from temperature differences as low as 27° F., at least 36° F. is highly desirable. Cold surface water along the west coast of the U.S. makes OTEC unsuitable until below the tip of Baja California; but the east coast of Florida, the Gulf of Mexico, Hawaii, Puerto Rico, Central America, tropical Africa, southern India, Indonesia and the Philippines are all possible locations for OTEC plants. (Charts: Department of Energy, Solar Energy Division)

baseline design of aluminum tube-and-shell heat exchangers with ammonia as a working fluid does lead to an economically competitive OTEC plant, even at 2.5 per cent thermal-to-electric power conversion — provided the plant is big enough. In fact, usable power can be generated when temperature differences shrink to 27° F., though a gradient of at least 36° F. is highly desired. An amusing illustration of the size impact is demonstrated by a current proposal to use an experimental one-megawatt (thermal) heat exchanger (already built under D.O.E. sponsorship) to power a small demonstration OTEC plant at 50 kilowatts. A colleague rather caustically pointed out that the resulting power is about the output of a Volkswagen engine — at a cost of perhaps $2.5 million for the total installation, OTECs have to be massive to be commercial. Nevertheless, the mini-OTEC is worth pursuing as proof of concept and as a research facility.

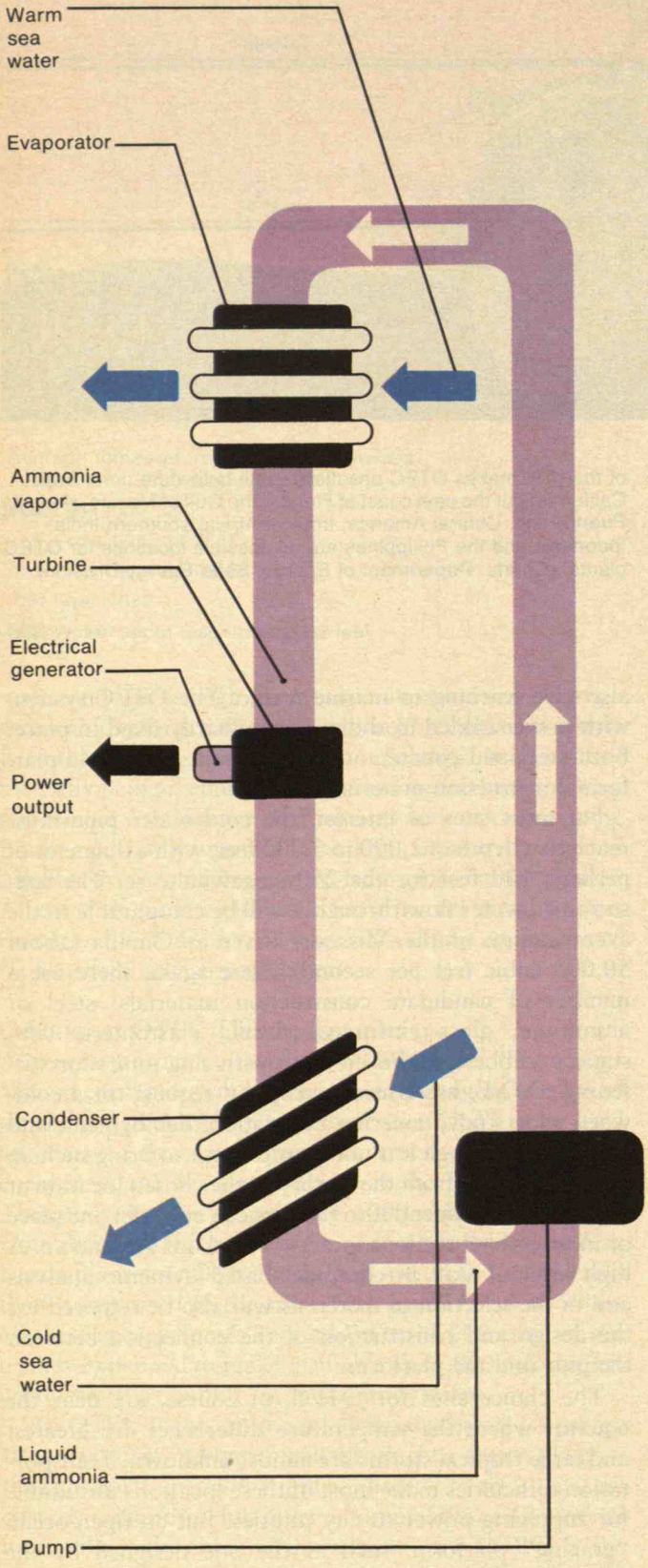
### Elements for a Final Design

The engineering challenges to be bridged demand solutions of scale rather than of technical innovation. Ship designs and structures used for offshore oil platforms have blazed the trail for the physical platform on which OTEC will be mounted. A general design goal is to isolate the platform as much as possible from the influence of the ocean surface, where the interaction of wind and wave can induce violent platform motions. A leading candidate is a large spar buoy configuration, with most of the platform mass several hundred feet underwater and a relatively small surface-piercing mast for access; this would also give warning to marine traffic. The OTEC system, with power cabled to shore, is necessarily fixed in place. Both steel and concrete are considered as possible platform construction materials.

For most sites of interest, the cold water pipe must reach to a depth of 2,000 to 3,000 feet, with a diameter of perhaps 100 feet for the 250-megawatt case. The self-sustained water flow through it will be comparable to the average flow of the Missouri River at Omaha (about 50,000 cubic feet per second). Here again, there are a number of candidate construction materials: steel or aluminum, glass-reinforced plastic, elastomeric substances (rubber), and even cloth with ring joints for stiffening. D.O.E. has issued a proposal request for a cold-water pipe study, covering fabrication, deployment, and mooring. Although it is not a simple task to bring such an unwieldy object from the factory to the chosen location at sea and then to upend it to the vertical, either in one piece or in assembled sections, practical methods are known. A high level of skill in computer-based dynamic analysis and in the selection of materials will also be required for the design and construction of the connection between the pipe and the platform.

The choice sites for OTEC, of course, are near the equator where the temperature differences are greatest and large tropical storms are almost unknown. Transportation difficulties make most of these locations unsuitable for supplying power to city utilities. But an open-ocean "grazing" platform, such as the one designed by the Johns Hopkins team could be used as the power supply

A closed-cycle system proposed to draw energy from the temperature difference between surface and deep ocean waters would operate just as any other heat engine. Cold fluid is heated and vaporized in a boiler or heat exchanger. This vapor at high pressure moves the blades of a turbine (and thence a generator) as it expands toward a cooling system in which the vapor is condensed back into liquid. In a conventional electric generating plant this "working fluid" is water, converted into steam by as much as 1,000° F. of heat in the boiler. In an OTEC plant, the working fluid is likely to be ammonia, vaporized by the narrow temperature difference between warm and cold sea water.




for an energy-intensive industry. The production of ammonia for agricultural use is attractive as it would only require hydrogen from seawater and nitrogen from the air, and shortfalls of ammonia from conventional sources are expected by 1985 if ammonia continues to receive over two per cent of the nation's supply of natural gas.

Moreover, ammonia — which can readily be transported and stored at room temperature in liquid form — can be decomposed into nitrogen and hydrogen and used in a fuel cell at high system efficiency to generate electric power at any time and place the power is needed. Thus, an OTEC system producing ammonia could make power available anywhere in the U.S. and would be particularly advantageous for regions such as New England where power costs are high because of dependence on imports of foreign oil or liquefied natural gas.

As already noted, a major cost element in OTEC is the heat exchangers (condenser and evaporator), operating on temperature differences of less than 40° F. They are big; so big that they will probably have to be manufactured at the yard where the platform is assembled. A Lockheed design for a single 25-megawatt modular unit requires some 640 miles of two-inch tubing, in either aluminum or titanium. Aluminum is cheaper but has a shorter design life than titanium; the prototype installations will probably use aluminum. There are likely to be a number of heat exchanger modules in a commercial OTEC installation. Among the reasons for this are ease of manufacture, handling, and installation; the need for symmetrical water discharge from the platform to avoid unnecessary demands on the station-keeping capability (either mooring or dynamic positioning); continuity of power output in case of downtime in any given module; and removal of module for maintenance and overhaul without moving the entire platform from the selected site.

The heat exchangers are also the battleground for the control of marine organisms. The problem is not so much macroscopic fouling by barnacles or the ingestion of fish — inlet screens will take care of that phase of the problem — as micro-fouling by slimes. If slime layers are allowed to build up and persist, the heat transfer efficiencies will quickly drop to an unacceptable level. Fortunately, the deep ocean waters are not much contaminated with slimes. Most of the problem in fouling occurs in the upper regions of the ocean. A number of methods have already been developed for slime control. These include mechanical cleaning by brushes or abrasive balls, fed periodically through the system; chemical attack by chlorine (copper tubing would be effective, but is ruled out by the use of ammonia); and thermal shock. Recent D.O.E.-sponsored studies in Puerto Rico and Hawaii indicate that fouling is not a major obstacle.

Once a final design has been confirmed, the construction period for a production OTEC plant, including deployment, should be around two years — comparable to the 18-month schedule of the similarly-sized offshore oil platform. The main platform of an OTEC plant should be good for at least 40 years. Aluminum heat exchangers would probably require major retubing in about 12 to 20 years; titanium heat exchangers should come close to matching the platform life. Though mechanical problems could creep into the rotating machinery (pumps and turbines), favorable environment and reasonably constant load should give them an exceptional lifetime.

### Crossing Over Economic Hurdles

After this rather general account of the technical challenges of OTEC, it is instructive to consider some of the economic aspects. The current estimate for the cost of a moored OTEC plant is about $2,000/kilowatt of capacity, including the 100-nautical-mile cable connection to shore. Typically, utilities in the U.S. anticipate a production capacity of two kilowatts per person served (only half of which is constantly-generating baseload). A minimum estimate, then, is about $2,000 per person as the required investment for an OTEC plant to supply baseload power to a city. A 200-megawatt plant would serve a city of 200,000 at a cost of $400 million (baseload requirement).

As already implied, OTEC will only be used on a commercial scale when it can generate useful amounts of power at a cost comparable with existing plants. Construction costs are the surpassing element in OTEC. An estimated cost of $1,000 to $1,500/kilowatt is predicted for delivered electric power after 1985, with improvements upon the heat exchangers. In comparison, costs for building fossil fuel plants are expected to range around $450/kilowatt and $1,000/kilowatt for nuclear plants (after 1985 in present dollars). But OTEC's constant source of free energy will soon turn over the advantage as a result of steady increases in the cost of fossil fuels and concern over their adverse effects on the environment.

Further off, we must foresee some ultimate limit on the availability of these fuels, though predictors of exhausted supplies have been disappointed about as often as Malthusian inferences on the size of the earth's population. With the predictions based on the present state of technical maturity of OTEC designs, it is estimated that cross-over point for oil-fired plants is about $12 a barrel (which has already occurred) and for coal-fired plants about $50 a ton (very probably in the late 1980s or early 1990s). The coal estimate is based on the cost of mining and transporting coal, leaving out impacts from air pollution and the greenhouse effect on the environment if coal consumption increases massively. The conclusion is that the OTEC power plant should have an economic advantage over fossil fuel plants and nuclear plants well before the year 2000.

The major economic hurdle will be facilitating the large capital formation for the initial construction phase in an industry which has been singed by a substantial investment in politically inoperable nuclear fission plants. There are several ways to reduce the impact of the initial capital demand. For instance, the preferred OTEC designs are modular, with the power modules separable from the main platform. There is no reason why these elements should have a common owner; in fact, the platform owner could lease docking space to one or more power module owners or operators, thus splitting up the capital burden into manageable chunks (like the equipment trusts used for passenger aircraft). The platform is seaborne, opening the possibility for a number of subsidies granted by the federal government to maritime enterprises. These include tax concessions, building subsidies, and favorable government-guaranteed interest rates. There is considerable scope for imaginative funding proposals.

In summary, OTEC is an attractive candidate as a contributor to U.S. energy self-sufficiency. It is a renewable source of base-load electricity, though limited in its geographical availability to the Gulf Coast and to island territories (Hawaii, Puerto Rico, and Pacific dependencies). The grazing concept for producing energy intensive products has a much wider area of siting — there are some 20 million square miles of suitable tropical waters near the equator. Furthermore, for tropical third-world countries, OTEC offers a valuable resource, if capital funding can be made available by the more developed countries. OTEC is environmentally benign and does not consume fossil fuels which are needed for other purposes (such as petrochemicals). No technological problems have been uncovered which will kill the OTEC concept; the engineering challenges appear to be those of scale rather than of technological difficulty. The materials are available; the construction methods are known. It deserves the support of a society which is confronted with a continuing appetite for energy, tempered by an increasing concern for the preservation of an acceptable environment on earth.

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# Assessing the Risk of an LNG Terminal

Ralph L. Keeney
Ram B. Kulkarni
Keshavan Nair

Accidents involving liquefied natural gas may endanger lives and property. How should the risks of its commerce be weighed by those who would bring this product to our shores?

Natural gas is used to meet 25 per cent of the energy needs of the United States, and there are strong arguments that favor its continued use: it burns cleanly; an efficient distribution system exists; and consumers prefer it as the fuel for heating homes and other buildings. Natural gas is also essential in the production of fertilizers and other chemicals.

Though demand has been increasing, U.S. production of natural gas has been declining since 1971 — a circumstance which leads us to plan to exploit the significant supplies of natural gas in many developing areas of the world where there is little or no demand for the gas *(see "Energy for the Third World" by William F. Martin and Frank Pinto, June/July, pp. 48-56)*. A growing international trade in natural gas is likely in the years ahead. Indeed, by 1990 the world trade in natural gas could rise to between 5.3 and 8.12 trillion cubic feet, with the U.S. as the principal user. The American Gas Association is of the opinion that U.S. imports of natural gas, which are currently 10 to 15 billion cubic feet per year, could reach 1.6 trillion by 1985 (about 10 per cent of the total gas supply), 2.4 trillion by 1990, and 3 trillion by 1995.

Natural gas is easily and cheaply transported by pipeline. But transportation where pipelines do not exist poses significant problems because of the large volume occupied by the gas at ambient temperatures. To solve this problem, a technology has been developed to convert natural gas to liquid by cooling it to a temperature of −259° F. (−162° C.), in which state it occupies 1/600th of the original volume. This liquefied natural gas (LNG) can then be shipped in specially constructed oceangoing tankers. A liquefaction facility is required at the source of the gas, and regasification is required before the fuel enters whatever distribution network is to bring the gas to its ultimate users.

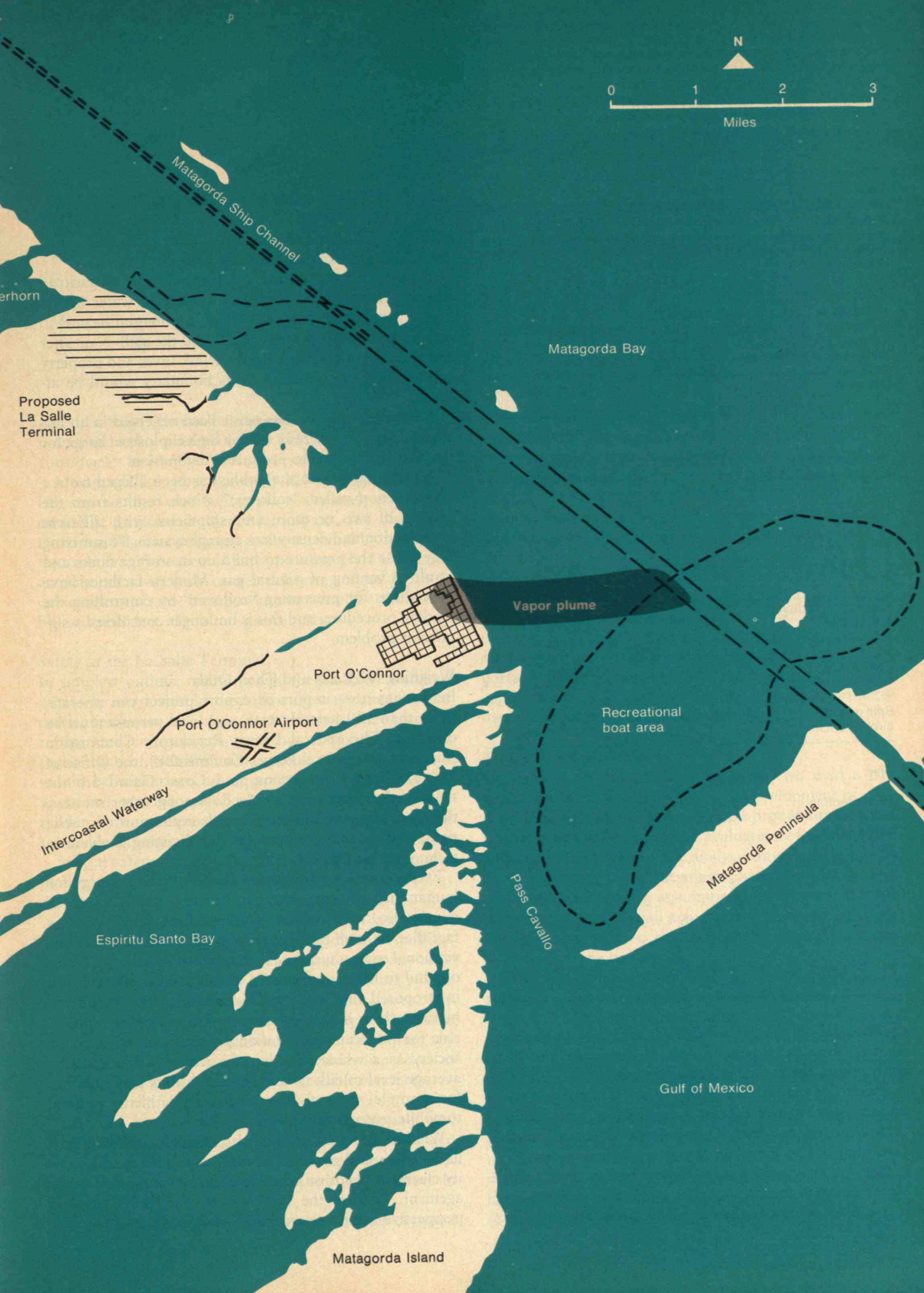
Liquefied natural gas is colorless and odorless, and by itself it will not burn. It weighs about 28 pounds per cubic foot and therefore will float on water. LNG will vaporize rapidly if exposed to ambient temperatures; in the vapor state it is not poisonous but could cause asphixiation due to the absence of oxygen. When dispersed in the air and when the concentration falls to between 5 and 15 per cent, the mixture is flammable.

### The Public Risks in LNG Commerce

The risks to the public in the handling of LNG arise because spilled LNG vaporizes rapidly. The vapor may either catch on fire at the location of the spill, resulting in a "pool fire"; or it may form a vapor cloud which can be carried downwind with the possibility of ignition and burnback toward the source.

In the unlikely event that there is a spillage of LNG on land from storage tank or piping failure, the LNG will vaporize quickly for a short period of time — two to three minutes — until the ground beneath it freezes. Thereafter, vaporization will continue to take place slowly. Vapor cloud formation is possible during the first few minutes and far less likely thereafter. LNG facilities are required to have fire suppressant equipment, and storage tanks must be provided with dikes which can, as a minimum, contain all the liquid stored (typically 90,000 cubic meters per tank); and a buffer zone is required between the dike and

Mapping a hypothetical LNG accident. The La Salle Terminal for receiving and vaporizing liquefied natural gas from Algeria would be built by the El Paso LNG Co. and its subsidiaries northwest of Port O'Connor on Matagorda Bay, between Galveston and Corpus Christi, Texas. To reach it, LNG carriers would enter the Matagorda ship channel from the Gulf of Mexico. As part of the authors' risk analysis, they studied the probability of a collision scenario in which one tank of an LNG carrier was ruptured so as to instantaneously release 19,400 cubic meters of LNG. A 10 m.p.h. east wind would move the resulting vapor cloud toward the town of Port O'Connor, where fatalities from possible ignition of the vapor cloud might exceed 400. But the probability of this specific episode is shown to be $2.71 \times 10^{-12}$, and the expected fatalities per year among residents and visitors to Port O'Connor due to the proposed LNG facility is $1.7 \times 10^{-5}$.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Matagorda Bay
Proposed
La Salle
Terminal
Vapor plume
Port O'Connor
Port O'Connor Airport
Recreational
boat area
Intercoastal Waterway
Matagorda Peninsula
Pass Cavallo
Espiritu Santo Bay
Gulf of Mexico
Matagorda Island

How could LNG be spilled in Matagorda Bay, Texas? Accidents may be inevitable in handling LNG, but the authors' risk analysis of the El Paso LNG Co.'s proposed facilities in Matagorda Bay indicates that they will be infrequent. The initiating accidents listed below turn out to be the most serious of many postulated, and these were examined to determine the public risk associated with each under various conditions of weather and population.

| Location, cause, and size of spill | Annual probability of accident event | Spill size |
|---|---|---|
| **Entrance:** | | |
| Most credible spill due to collision | $3.46 \times 10^{-5}$ | 19,400 $m^3$ instantaneously |
| Maximum credible spill due to collision | $9.28 \times 10^{-6}$ | 38,800 $m^3$ in 9 minutes |
| Spill due to ramming | $7.59 \times 10^{-8}$ | 10,000 $m^3$ in 12 minutes |
| Spill due to aircraft crash | $1.21 \times 10^{-8}$ | 10,000 $m^3$ in 12 minutes |
| **Harbor:** | | |
| Most credible spill due to collision | $6.49 \times 10^{-7}$ | 19,400 $m^3$ instantaneously |
| Maximum credible spill due to collision | $1.76 \times 10^{-7}$ | 38,800 $m^3$ in 9 minutes |
| Spill due to ramming | $2.10 \times 10^{-7}$ | 10,000 $m^3$ in 12 minutes |
| Spill due to aircraft crash | $9.23 \times 10^{-8}$ | 10,000 $m^3$ in 12 minutes |
| **Pier:** | | |
| Most credible spill due to collision | $1.01 \times 10^{-7}$ | 19,400 $m^3$ instantaneously |
| Maximum credible spill due to collision | $2.73 \times 10^{-8}$ | 38,800 $m^3$ in 9 minutes |
| Spill due to ramming | $1.10 \times 10^{-5}$ | 10,000 $m^3$ in 12 minutes |
| Spill due to aircraft crash | $5.93 \times 10^{-7}$ | 10,000 $m^3$ in 12 minutes |

the boundary of the facility. Consequently, the public risk (that is, the risk to persons outside the facility) of LNG spills within the facility is considered minor.

The major concern for public safety is connected with an LNG spill on water or at a terminal as a result of a tanker-related accident. One postulated hazard is the possibility of a flameless vapor explosion when LNG comes in contact with water. This represents a very rapid vaporization of the LNG but does not involve combustion; it is a physical rather than chemical phenomenon. Tests indicate that the pressures generated by such an explosion — if in fact it could occur — are relatively small (100 pounds per square inch) even very close to the surface of the liquid and attenuate rapidly with distance.

A more serious hazard is presented by a scenario in which a vapor cloud from LNG spilled on water ignites either at the spill location — with a potential hazard to people and property in the vicinity of the spill — or after the vapor cloud is carried downwind. Lives and property within the cloud or close to its boundary would be affected.

An LNG detonation has never been observed in an unconfined space, and tests using a high explosive charge for ignition have failed to produce a detonation.

A potential risk to the public has been alleged from a phenomenon called "rollover," which results from the mixing of two or more LNG shipments with different composition and density in a storage system. This mixing may cause the pressure to build up in storage tanks and result in venting of natural gas. Modern facilities have procedures for preventing "rollover" by controlling the loading procedure, and this is no longer considered a significant problem.

### Weighing the Risks and Their Odds

Before any LNG import or export project can operate, more than 130 federal, state, and local permits must be obtained. The Federal Energy Regulatory Commission (formerly the Federal Power Commission), the Office of Pipeline Safety Operations, and Coast Guard are the major federal agencies involved. Among other matters, these agencies are concerned with evaluation of public risks, and that turns out to be a challenging problem in technology and policy.

Every system for producing and converting energy for human use presents hazards, and evaluating these in quantitative terms is critically important. It is a curious fact that we tend to take for granted the hazards in conventional energy systems, such as those based in coal and oil, and to focus our concern on the public risk involved in proposed new energy developments. To complicate matters, there is no clear definition of acceptable public risk for particular populations, particular activities, or society as a whole; clearly, one accepts a higher-than-average level of risk in certain occupations (coal mining, for example) and activities (competitive athletics and automobile transportation).

What is in fact the public risk associated with handling liquefied natural gas? The answer for any particular facility clearly depends on its design, size, location, and management. Perhaps the best way to put these issues in perspective is with an example — an analysis of the pro-

Should there be an LNG accident in Matagorda Bay, Texas, how will the winds carry the flammable vapor clouds which may be formed? These probabilities of various winds and air turbulences (increasing turbulence is represented by higher "stability classes") were an essential input into the LNG risk analysis described in the accompanying article. To assure a conservative result, winds of 20 miles an hour and greater were included in the 15-m.p.h. category since this results in longer time periods until the vapor cloud is dispersed.

| Wind speed (m.p.h.) | Stability class | Wind direction | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | North | Northeast | East | Southeast | South | Southwest | West | Northwest |
| 5 | C | 0.0775 | 0.1042 | 0.0545 | 0.0230 | 0.0357 | 0.1986 | 0.1615 | 0.0916 |
| 5 | D | 0.0619 | 0.0763 | 0.0499 | 0.0273 | 0.0382 | 0.0906 | 0.0817 | 0.0833 |
| 5 | F | 0.0872 | 0.1341 | 0.2582 | 0.1374 | 0.2379 | 0.4742 | 0.4912 | 0.1277 |
| 10 | C | 0.0968 | 0.1200 | 0.1085 | 0.0814 | 0.0664 | 0.0614 | 0.0364 | 0.0763 |
| 10 | D | 0.1517 | 0.1809 | 0.1856 | 0.1460 | 0.1378 | 0.0673 | 0.0841 | 0.1527 |
| 10 | F | 0.0549 | 0.0600 | 0.0853 | 0.1050 | 0.1284 | 0.0635 | 0.0465 | 0.0392 |
| 15 | C | 0.0065 | 0.0197 | 0.0260 | 0.0448 | 0.0358 | 0.0034 | 0.0058 | 0.0093 |
| 15 | D | 0.4636 | 0.3048 | 0.2320 | 0.4351 | 0.3198 | 0.0411 | 0.0929 | 0.4198 |

posed La Salle Terminal, a marine terminal and LNG vaporization facility planned by the El Paso LNG Co. and its subsidiaries in Matagorda Bay, Texas.

Matagorda Bay, approximately 120 miles southwest of Houston on the Texas Gulf coast, is a sparsely populated area. The proposal is to receive, process, and distribute LNG from Algeria, delivered to the terminal by a fleet of LNG carriers. There would be approximately 143 carrier arrivals per year, each carrier delivering some 125,000 cubic meters of LNG; total production would be about one billion cubic feet of natural gas per day.

### Safety at the La Salle Terminal

In simplest outline, operations at the La Salle Terminal would be conducted in the following way: after an LNG carrier berths, its LNG cargo would be transferred through refrigerated (cryogenic) piping to one of three LNG storage tanks, each of 100,000 cubic meters capacity. The LNG would be withdrawn as required from these tanks, revaporized, and then piped to consumers through a high-pressure intrastate pipeline. No surface transportation of LNG is anticipated.

Special safety procedures and techniques are proposed in all phases of the design, construction, and operation of the La Salle Terminal and the LNG fleet serving it.

Storage tanks will be diked and will be designed to minimize spillage, and there will be additional spill impounding areas at the facility. This assures that any accidental release of LNG and its subsequent spreading will be contained at all times within the plant boundaries. The facility will be provided with automatic vapor dispersion and fire control systems adequate to minimize any hazards from thermal radiation or vapor dispersion at any plant boundary line under any credible weather conditions.

The LNG carriers will be of special double-hull and double-bottom construction and will use sophisticated anti-collision and navigational systems. Special U.S. Coast Guard operating procedures will be in effect in Matagorda Bay.

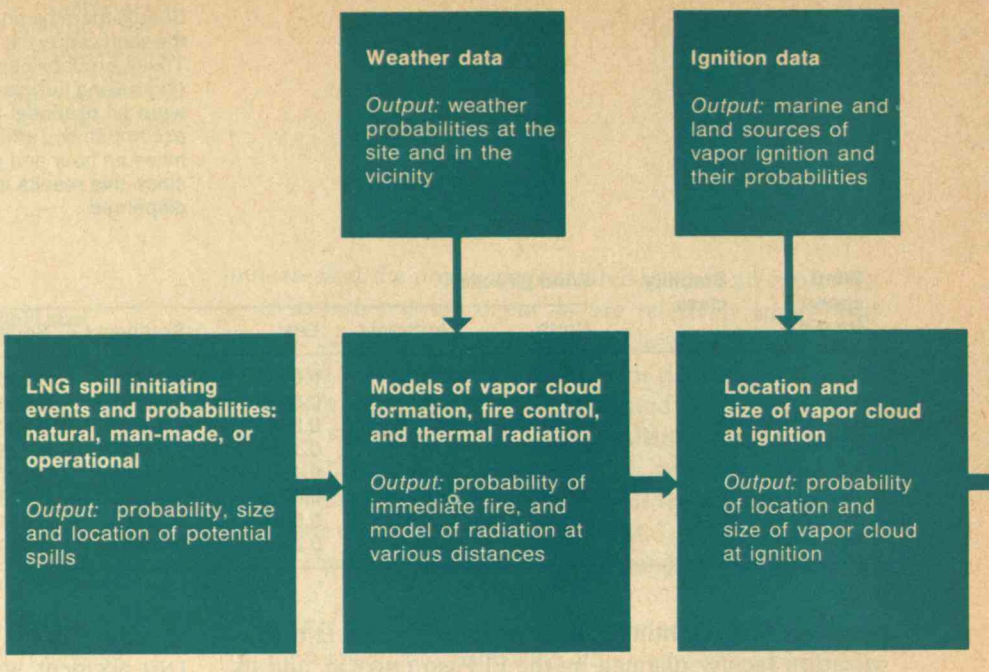
But despite all of these safety considerations designed to reduce to an extremely low level the likelihood of an LNG accident with consequences to the public, such an event is possible. It could be initiated by a spill of LNG resulting from a ship collision or a terminal-equipment malfunction. The circumstances required to cause such a spill suggest that the vapor being formed would be immediately ignited, resulting in a pool fire. If the released LNG were not immediately ignited the very cold liquid (−260° F.) would rapidly evaporate, forming a cloud of gas, heavier than air, moving across the surface of the earth. If this cloud should come into contact with an ignition source, such as a gas pilot light, the flame of a cigarette lighter, or an electric spark, before the ratio of vaporized LNG to air becomes too low to allow ignition, the vapor cloud could ignite and burn, leading to property damage, injuries, and perhaps fatalities.

### The Risk Analysis Model

To analyze the risk of such accidents, we used a risk analysis process which included the development of accident scenarios and their associated probabilities, quantification of public risks, and evaluation of public risks. The components of the risk analysis model are indicated in the figure on p. 68. The complexities required that we make some simplifying assumptions, but the spirit of the analysis required that all assumptions be stated explicitly and conservatively so that our analysis would tend to overestimate the public risks.

Any risk analysis begins with an accident scenario, a sequence of events that must occur for public risk to exist. It must incorporate assumptions about the nature and location of the hypothetical LNG spill, the wind and weather conditions, the sources of ignition, and the effectiveness of spill and fire control systems. These are all built into an event tree, such as that shown at the top of p. 72. A representative accident scenario could then be described as follows: an LNG carrier collision occurs in the harbor, releasing an LNG spill of a specified size. There is no immediate ignition, so a vapor cloud forms. The wind is from the east at 10 miles per hour; the eighth ignition source ignites the vapor cloud. The event tree shows that

Problem: to examine the public risks from possible releases of LNG from the proposed La Salle Terminal. Solution: a formal risk analysis according to the model shown here. The analysis is accomplished in three stages: develop accident scenarios and their associated probabilities (the three columns at the left); quantify public risks associated with each probability; and, finally, evaluate the risks by comparing them with those involved in other human activities.




this chain of unlikely events must take place in a specific sequence.

In the risk analysis model, we calculate the annual probability of a particular scenario involving vapor cloud travel as the product of the following factors:

☐ The annual probability of the initiating accident,
☐ The probability of no immediate ignition for that accident,
☐ The probability of the wind direction,
☐ The probability of the wind speed and the air stability, given that wind direction, and
☐ The probability that the nth ignition source ignites the vapor cloud.

Similarly, the probability of a particular accident scenario which results in a pool fire is equal to the annual probability of the initiating accident multiplied by the probability of immediate ignition.

### Analyzing the Risk at Matagorda

In the course of our analysis, we constructed accident scenarios and calculated probabilities for all combinations of these individual events, and finally we computed the public risks due to LNG terminal operations.

There are no generally accepted criteria for evaluating public risk. The approach used here was to compare risks generated from this project with existing risks to the public, with risks from alternate energy sources, and with levels of acceptable public risks suggested in the literature. We examined these risks using four criteria:

☐ *Societal risk* — the total expected fatalities per year.
☐ *Individual risk* — the probability of an exposed individual becoming a fatality per year.
☐ *Group risk* — the probability of an exposed individual in a specific group becoming a fatality per year.
☐ *Risk of multiple fatalities* — the probability of exceeding specific numbers of fatalities per year.

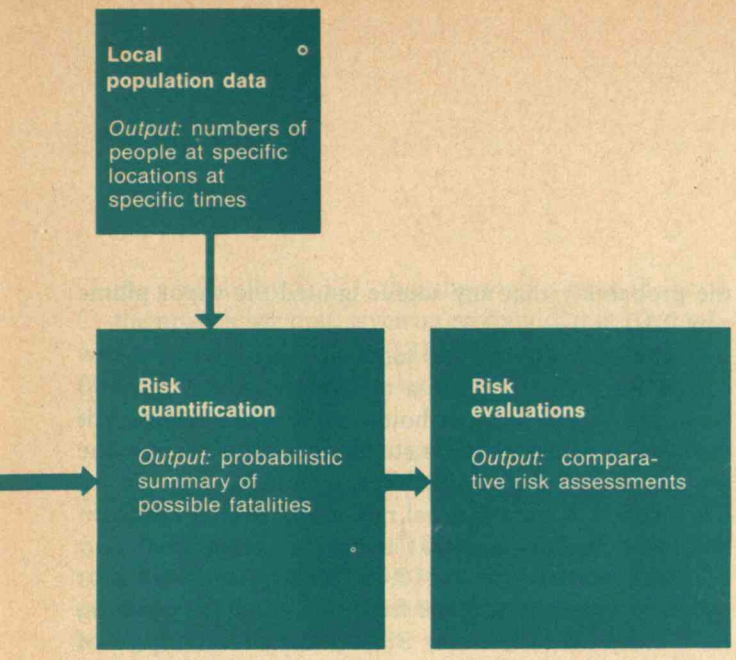
We categorized the events that might cause LNG spills as follows:

☐ Natural hazards (for example, hurricanes and earthquakes) which affect the facilities.
☐ External man-made hazards (for example, aircraft crashes) which affect the facilities.
☐ Accidents involving the LNG carrier fleet.
☐ Accidents within the La Salle Terminal.

### Analyzing the Dangers of Natural Events

Our analysis of the various natural hazards, including earthquakes, severe winds, storm waves and tsunamis, and meteorites suggested that none of these represent significant public risk in comparison to the risks associated with other types of accidents. The likelihood that an earthquake would produce a ground acceleration at the La Salle Terminal site large enough to exceed the design specification of the storage tanks is approximately $10^{-11}$ per year. Even if the tank did rupture with such an earthquake, the analysis for the onshore facilities indicates that public risk is essentially nil. There is a higher probability of pipe breaks than of storage tank failure due to ground motions, but the analysis indicates that the results are inconsequential to public risk.

The main source of severe winds in the vicinity of Matagorda Bay is hurricanes. The primary concern with wind is its effect on the storage tanks, since all LNG carriers will leave and remain outside of Matagorda Bay if any winds greater than 60 m.p.h. are forecast or observed. The tanks are designed to withstand an instantaneous gust of 217 m.p.h. and a one-minute wind of 166 m.p.h. Meteorological data indicate that the latter occurs once every 100 years and the former once every 200 years. Because of the safety factors in design standards, it is unlikely that a storage tank would begin to fail even when the design wind is exceeded. But even if the tank failed completely, under these conditions wind turbulence would disperse the vapor plume before it passed terminal boundaries if a pool fire had not been ignited on the site at the point of rupture.




There are no known faults capable of generating significant tsunamis in Matagorda Bay. Furthermore, operating policy will require that in storm conditions all LNG ships leave Matagorda Bay; and since warning of impending large waves would be available, the possibility that these could cause ship accidents and contribute to public risk is believed to be negligible.

The probabilities of a meteorite penetrating a ship's tanks in the entranceway to the harbor, in the harbor, or at the pier were calculated to be $3.23 \times 10^{-10}$, $5.49 \times 10^{-10}$, and $9.32 \times 10^{-9}$ per year, respectively — over two orders of magnitude smaller than the probability of ship collisions. We considered this probability essentially negligible and made no further analysis of this possibility. The likelihoods of meteorites penetrating terminal storage tanks and rupturing terminal pipelines were also essentially negligible, and since accidents in these cases would be contained within the terminal boundary, they were not investigated further.

**Man-made Hazards: Aircraft, Sabotage, and Collisions**

There are no major airports in the vicinity of Matagorda Bay, though small planes operate at the local Port O'Connor airstrip and there is a helicopter landing site in Port O'Connor from which approximately 25 flights leave daily for oil platforms in the Gulf of Mexico. It is assumed that there is no risk to the public from airplane crashes into the storage tanks or LNG pipelines, because the consequences of such events would be confined to the terminal area. For crashes of airplanes into ships, we assumed that up to 10,000 cubic meters of LNG might be released in 12 minutes, and this scenario is included in the risk analysis. Accident possibilities from helicopter flights are not included in the analysis, because it is assumed that flight patterns can be arranged to avoid operations where LNG carriers are operating.

Qualitative examination of the potential risks due to sabotage indicates that the possibility of sabotage by determined terrorists cannot be completely eliminated by reasonable engineering or security systems. However, we believe that immediate ignition would very likely occur because of the violence required of a saboteur seeking to release the LNG, and this means that the consequences would be confined to the spill area. Furthermore, the decision to operate LNG terminals anywhere in the U.S. implies acceptance of some risk of terrorism.

The most serious accidents involve the collision of LNG carriers with other vessels, rammings of stationary or floating objects, and grounding of LNG carriers. Their probabilities were calculated for three areas of operations in the Matagorda Bay:

- ☐ The entranceway, the immediate approach route to and through the cut in Matagorda Peninsula;
- ☐ The harbor, the ship channel within Matagorda Bay; and
- ☐ The piers, the waters between the ship channel and the berth.

Either one or two cargo tanks may be involved in such a collision. The most credible spill event due to collision turns out to be the rupture of one cargo tank involving 19,400 cubic meters of LNG. The maximum credible spill event due to collision is considered to be the simultaneous rupture of two adjacent cargo tanks, involving up to 38,800 cubic meters of LNG. The most credible spill due to ramming is 10,000 cubic meters. The analysis of grounding accidents indicated a probability for cargo tank rupture so small as to be statistically insignificant. All these findings are summarized in the table shown on page 66. Since land spills have been ruled out as insignificant to public risk, the attention in the rest of our study of public risks associated with the operation of the La Salle Terminal was devoted entirely to analyzing water spills.

Vaporization of the LNG would commence immediately following a cargo tank penetration. Any heat source of sufficient temperature and duration could cause ignition

This table summarizes the results of the risk analysis of the proposed LaSalle Terminal near Port O'Connor, Texas. The authors computed these probabilities of death in any single year for individuals in population groups which might be affected. There is one chance in $2.5 \times 10^{-11}$ that a permanent resident in the city would be a victim. Risks to visitors using Port O'Connor's beach and to boaters in the harbor are somewhat greater — but remain absolutely very small. Sensitivity analyses indicated these results were not significantly affected by the basic assumptions in the model.

| Group | Expected fatalities per year | Number of people sharing the risk | Risk per person per year |
|---|---|---|---|
| Permanent population in Port O'Connor | $2.0 \times 10^{-8}$ | 800 | $2.5 \times 10^{-11}$ |
| Permanent population in Indianola | $1.3 \times 10^{-7}$ | 80 | $1.7 \times 10^{-9}$ |
| Transient daytime visitors | $2.5 \times 10^{-6}$ | 2500 | $9.9 \times 10^{-10}$ |
| Individuals in boats | $1.35 \times 10^{-5}$ | 3000 | $4.5 \times 10^{-9}$ |
| All individuals exposed to risk | $1.7 \times 10^{-5}$ | 9000 | $1.9 \times 10^{-9}$ |

of this vapor. The primary ignition sources would be the friction and sparking generated by the immense forces involved in the penetration; these would probably generate temperatures from 1,600° to 2,700° F., far in excess of the ignition temperature of methane in air (1,000° F.). Secondary ignition sources on the carrier, such as boilers, galley fires, electrical cables, and light fixtures, will also be present and exposed to the spilled LNG as a result of whatever accident is taking place. We assume that immediate ignition will almost surely occur under such circumstances; the probability assumed is 0.99.

If immediate ignition does not occur, and in cases of accidental spills caused by negligence on board carriers (where immediate ignition may not occur) the characteristics of wind, on-shore ignition sources, and public activities become important in computing public risk. The movement and behavior of an LNG plume would depend on wind direction, wind speed, and air stability. For the most credible spill of one tank (19,400 cubic meters spilled instantaneously), with a 10 m.p.h. wind and typical air stability, the vapor cloud could travel up to 3.31 miles, if not ignited, in roughly 25 minutes. Thereafter the LNG would be dispersed so much that its average concentration would be below the lower flammable limit of 5 per cent. It is within this 25-minute period that the probability of ignition — and then of injury and death due to ignition — must be critically analyzed.

A vapor plume can be ignited from a variety of sources such as spark plugs, open flames, pilot lights, and electrical sparks due to short circuits. Because of the difficulty of tabulating all possible ignition sources, we conservatively assumed that each house or building and each recreational boat or commercial fishing ship has one ignition source. To assume fewer sources is conservative because it implies a larger likelihood that a vapor cloud would cover a larger area before ignition. It was assumed that the probability that any source ignited the vapor plume was 0.1.

In analyzing injuries and fatalities due to burns, we assumed for this study that a thermal radiation of 5,300 B.t.u. per square foot per hour would be the lower limit resulting in fatalities. (This standard is conservative; one would actually expect only blistering of skin exposed for five seconds to such thermal radiation.) Such a radiation level would be found 1,100 feet from the center of an LNG pool fire resulting from 10,000 cubic meters of LNG spilled in 12 minutes, 2,500 feet from a pool fire resulting from either the 19,400 or 38,800 cubic meter spills of LNG, and 525 feet from a vapor plume fire.

Having agreed on these assumptions, we needed information on the distribution of population in the vicinity of the La Salle Terminal to determine the expected annual number of public fatalities and the annual risk levels to individuals (that is, the probability that any individual might become a fatality per year) due to the LNG terminal operation. This turned out to present some unexpected complications because of large seasonal and weekly fluctuations in the population. After preliminary analysis, we decided that three combinations — nontourist season (November through March), tourist weekends, and tourist weekdays — would be necessary to adequately describe population distributions. The risk quantification considered each of these cases separately. In the end, our population study indicated that we could reasonably assume 3.62 people per permanent household, 4.02 people per occupied transient household, 4.5 people per recreational boat, and 2.5 people per commercial fishing boat.

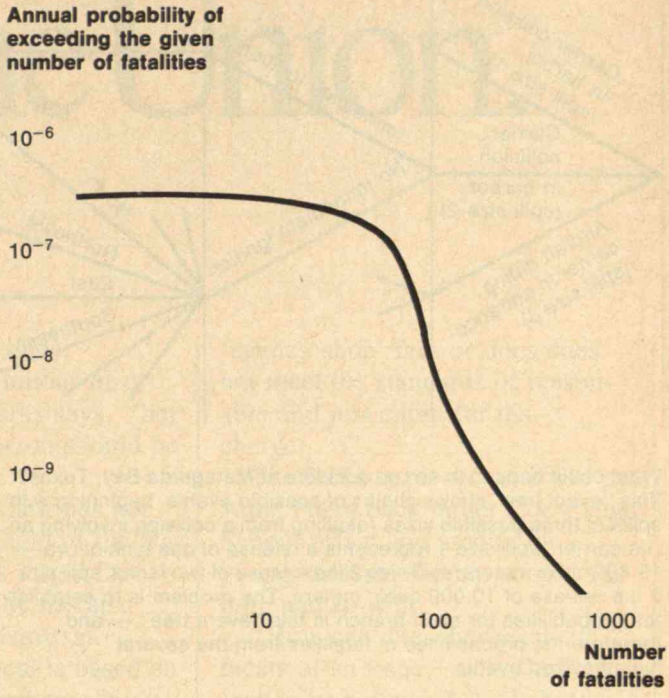
### An Illustrative Calculation

To show how all this information was used, we illustrate the calculation of the average number of fatalities under one accident scenario: a collision between an LNG carrier and another ship in the harbor at the intersection of the ship channel and intercoastal waterway *(see the map on page 65)* on a weekday during the tourist season. This collision produces an instantaneous one-tank spill of 19,400 cubic meters of LNG. Furthermore, the spill does not immediately ignite, so that a vapor cloud forms. The wind is from the east at 10 m.p.h. with typical air stability. The eighth ignition source ignites the vapor cloud.

The probability of this accident scenario is the product of the following factors:

- ☐ the annual probability of a collision releasing one tank of LNG (most credible spill) in the harbor during a weekday in tourist season (the annual probability is $6.49 \times 10^{-7}$ [*table, page 66*]; the probability that this will occur on a tourist season weekday is $2.33 \times 10^{-7}$);
- ☐ the probability (0.01) of no ignition in this collision;

There is one chance in 100,000,000 that there will be more than 100 fatalities in Port O'Connor, Texas in any one year due to an accidental spill of LNG near the proposed La Salle Terminal of El Paso LNG Co. This chart is the result of the authors' risk analysis, utilizing the likelihood of the original accident, the likelihood of adverse winds and air conditions, the likely number of people and their distribution in Port O'Connor, and the likelihood that vapor from the spilled LNG will be ignited before it disperses. The chances of a larger loss of life is less — one in 10 billion for 750 fatalities in any given year.




the Matagorda Bay area. The probability of exceeding a specified number of fatalities in a given year is shown above.

☐ the probability (0.131) that the wind is from the east;
☐ the probability that, given an east wind, it is 10 m.p.h. with the assumed stability (0.1856 — *table, page 67*); and
☐ the probability that the eighth ignition source ignites the vapor cloud (0.0478).

The calculation, using the probabilities indicated, is:

$$(2.33 \times 10^{-7})\ (0.01)\ (0.131)\ (0.1856)\ (0.0478) = 2.71 \times 10^{-12}.$$

To calculate the expected fatalities from this accident scenario on a tourist-season weekday, we calculate the maximum extent of the flammable vapor plume (if it is not ignited) and superimpose this area on a map of the Matagorda Bay area (*see page 65*). Then we assemble a count of the population in this plume area, using the tourist season weekday distribution of occupied houses, boats in the harbor, and transient population. The expected number of recreational boats in the plume's path is two; no commercial boats are assumed in this area on tourist season weekdays. On such days an average of 1,000 daytime transient visitors are in Port O'Connor, essentially all of them on the beach to the east of the town. The plume covers 34 per cent of the beach, and so we assume that 340 daytime transient visitors are within the vapor cloud. Thirty-seven permanently-occupied dwellings and 103 houses occupied by transients — a total of 140 households and as many ignition sources — are covered by the maximum possible plume. Assuming one person is away from each household, the average weekday daytime occupancy of these houses is taken as 2.62 and 3.02, respectively, a weighted average of 2.91.

If the vapor cloud is ignited by the eighth ignition source, we know that it is ignited by the sixth house encountered; the two boats count as potential ignition sources. All people within this cloud at the time of ignition are assumed to be fatalities, so the expected number of fatalities in the cloud is

$$2(4.5) + 340 + 6(2.91) = 366.46.$$

In addition, we assumed that all individuals within 525 feet of the vapor cloud fire would be fatalities if exposed to thermal radiation. Based on the average population density of Port O'Connor, this could be 230 individuals, of whom 20 per cent might be outdoors and hence fatalities. Hence, the total expected fatalities from the illustrative scenario on a summer weekday is 412.46. If the probability of such an accident is $2.71 \times 10^{-12}$, the contribution of this particular accident scenario during a tourist season weekday to the overall annual expected fatality rate is $1.118 \times 10^{-9}$.

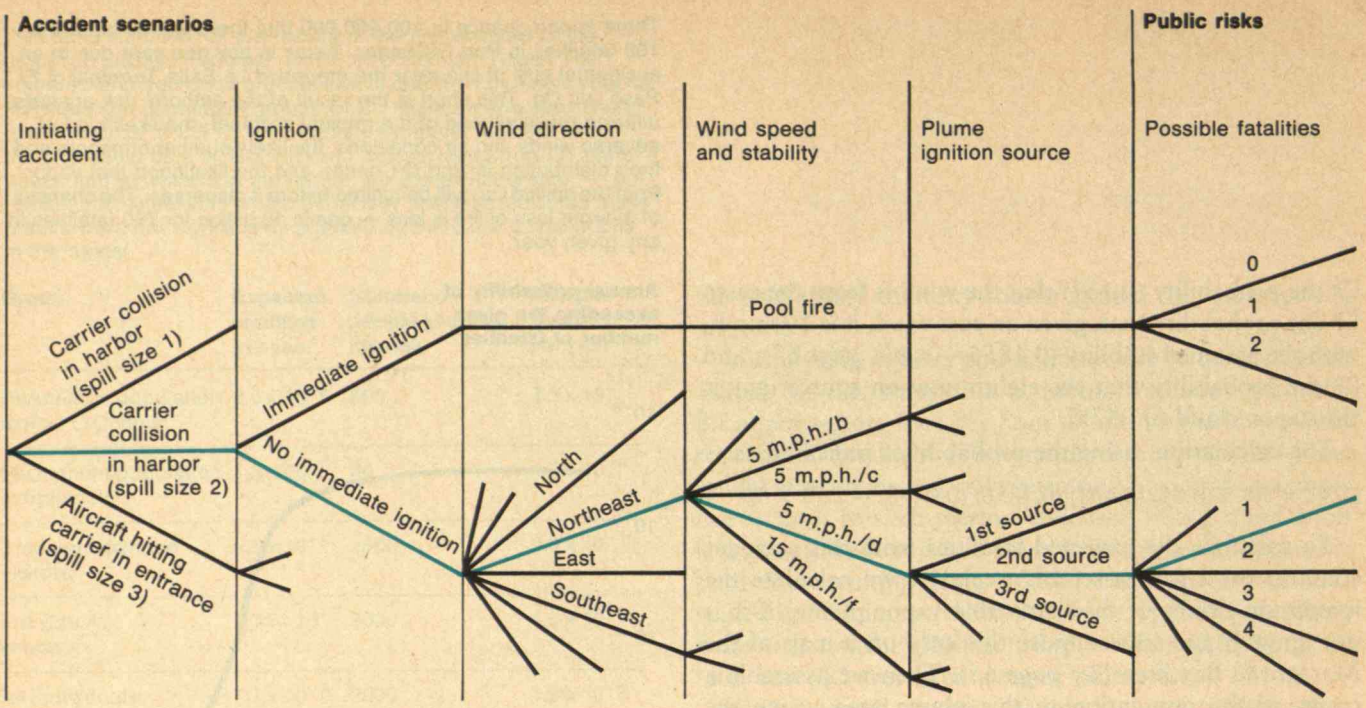
Similar calculations were made for all other accident scenarios leading to the table on p. 70, showing annual expected fatalities among different population groups in

### Risk Evaluation: How LNG Compares

To put these figures in perspective, it's necessary to compare them with similar figures for other forms of energy production.

The La Salle Terminal is designed to receive and vaporize approximately one billion cubic feet of natural gas per day. This is equivalent to the power produced by eighteen 1,000-megawatt electric power plants operating at a 70 per cent capacity factor. Based on 1970 data for the State of Wisconsin used by W. A. Buehring, the expected number of deaths to the public due to transporting fuel or direct deaths due to plant accidents for a 1,000-megawatt coal facility was 0.695 per year. The implication for 18 such plants is 12.51 expected fatalities per year; this compares with La Salle's expected level of 0.000,017. Buehring's corresponding number for 18 1,000-megawatt nuclear plants is 0.36 expected fatalities per year.

Other individual risk levels due to government and private activities have been computed. The risk to an average individual in the U.S. due to fire is 16,000 times greater than the risk to an individual exposed to the operations of the proposed La Salle Terminal. The group with the highest annual risk from the proposed LNG facility is people in boats. The risk is $4.5 \times 10^{-9}$ per person — one chance in approximately 220 million. From the La Salle Terminal,




What could happen in an LNG accident at Matagorda Bay, Texas? This "event tree" shows chains of possible events, beginning with spills of three possible sizes resulting from a collision involving an LNG carrier. Spill size 1 represents a release of one tank of LNG — 19,400 cubic meters; spill size 2 the release of two tanks, spill size 3 the release of 10,000 cubic meters. The problem is to establish the probabilities for each branch in this "event tree" — and therefore the probabilities of fatalities from the several hypothesized events.

the annual risk per person in Port O'Connor is $2.5 \times 10^{-11}$. The expected public risk due to gas distribution systems in the U.S. is $5.15 \times 10^{-7}$ per individual per year, which represents one chance in 1.9 million; this is 271 times as great as the possibility of death due to the operations of the proposed La Salle Terminal. Public fatalities due to electric shock in electrically wired residences are $1.11 \times 10^{-6}$ per individual per year.

To help interpret these risks, consider the following. Approximately 65 meteorites weighing more than one pound hit the United States each year; if one owns a one-floor house with 3,050 square feet, the probability that one of these meteorites will hit that house within a year is $1.9 \times 10^{-9}$. This is identical to the average individual risk to operation of the La Salle Terminal.

## Quantified Public Risk

The method of formal risk analysis described in this article has several important features: it permits integration of judgments from experts in various fields into a logical framework, assumptions can be stated explicitly, sensitivity analyses can be conducted to appraise the significance of the assumptions, and the public risk can be systematically estimated. In addition, because explicit risks are assigned, strategies to reduce risks can be identified. The analysis showed clearly that the risks to the public from the operation of the La Salle Terminal were below those to which the population in the vicinity of the terminal is exposed at the present time. The study was used in preparing the safety analysis report submitted to the Federal Power Commission. The final Environmental Impact Statement issued by the Federal Power Commission has stated that the levels of public risk associated with the La Salle Terminal facility are acceptable.


**Suggested Readings**

Buehring, W. A. (1975). "A Model of Environmental Impacts from Electrical Generation in Wisconsin," Ph.D. dissertation, Department of Nuclear Engineering, University of Wisconsin, Madison.

Drake, E. and Reid, R. C., "The Importation of Liquefied Natural Gas," *Scientific American,* April 1977, Vol. 236 No. 4.

Office of Technology Assessment, "Transportation of Liquefied Natural Gas," Congress of the United States, September 1977.

Starr, C., (1969). "Social Benefit Versus Technological Risk," *Science,* 1965, p. 1232.

Van Horn, A. J. and Wilson, R. (1976). "Liquefied Natural Gas: Safety Issues, Public Concerns, and Decision Making," Energy and Environmental Policy Center, Harvard University, Cambridge, Mass.



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The authors acknowledge the contributions to the study by Ivan Schmitt and Randall I. Cole (who directed the study at El Paso LNG Co.), Joe Porricelli, and Hal Wesson.

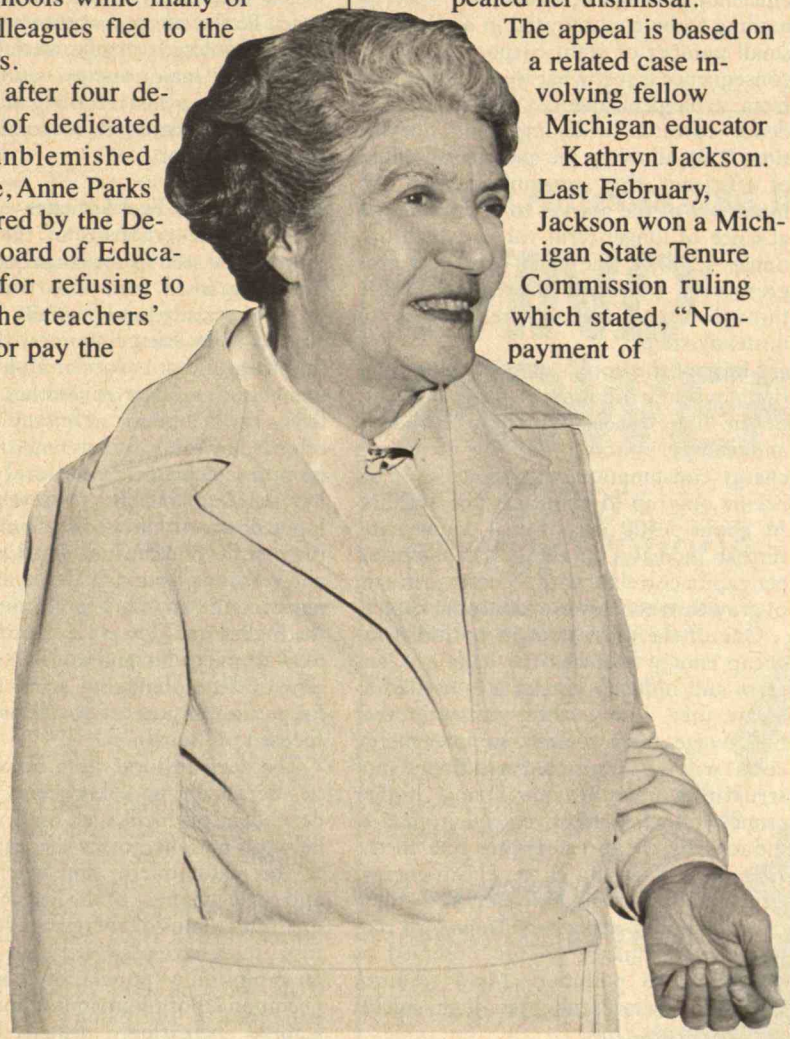
# She Failed... To Join The Union.

On March 11, 1978, Anne Parks, a Detroit educator for over 40 years, was fired.

She hadn't neglected her education—she had a master's degree and a Ph.D.

She hadn't neglected her students—she stayed in Detroit city schools while many of her colleagues fled to the suburbs.

But after four decades of dedicated and unblemished service, Anne Parks was fired by the Detroit Board of Education—for refusing to join the teachers' union or pay the equivalent of union dues.



"I'm not against unions or organizations," Dr. Parks says, "but I don't think any person should be forced to join one."

The devoted educator has not given up. With the help of the National Right to Work Legal Defense Foundation, she has appealed her dismissal.

The appeal is based on a related case involving fellow Michigan educator Kathryn Jackson. Last February, Jackson won a Michigan State Tenure Commission ruling which stated, "Non-payment of 'agency shop' fees or dues does not meet the standards of reasonable and just cause for discharge. . . ."

The Jackson precedent could put Anne Parks back in her Cody High School office and among the young students she has served so long and so well.

"How can a teacher teach all facets of an issue," asks Dr. Parks, "when he believes he is beholden to the union for his salary and other benefits? Teachers are responsible to the public, not to union officials."

Anne Parks and Kathryn Jackson are fortunate. They found legal help. But how many others like them haven't?

The National Right to Work Legal Defense Foundation is helping everyone it can—currently in more than 80 cases involving academic and political freedom, protection from union violence, and other fundamental rights.

If you'd like to help teachers like Anne Parks fight for real academic freedom, write:

The National Right to Work Legal Defense Foundation
8316 Arlington Boulevard
Suite 600
Fairfax, Virginia 22038

# Energy Efficiency's Fatal Flaw

*The Unsteady State: Environmental Problems, Growth, and Culture*
Kenneth E. F. Watt, Leslie F. Molloy, C. K. Varshney, Dudley Weeks, Soetjipto Wirosardjono
Honolulu: The University Press of Hawaii, 1977, ix + 287 pp.; $12.95

**Reviewed by Charles Ryan**

When politically acceptable solutions are ineffective, and effective solutions are politically unacceptable, it is time to watch for a sudden turn of events. I remember watching the evolution of the Vietnam War and thinking that it could not end within the confines of Washington's expectations, and that given the physics and politics of the situation, a surprising turn of events would occur down the road. And when it came, the debacle was sudden.

*The Unsteady State* describes the possible breakdown of global society because of uncontrollable fluctuations in unemployment, food, housing, crime, health care, and education that result from its unstable structure. According to the authors, the physics and politics of the global situation cannot fulfill the growth expectations of nations. There will be a turn of events in the future, and the developed countries will fare the worst.

### A Vulnerable Instability

Why is there an unsteady state? For the team of authors — a zoologist, a soil biologist, a social scientist, a statistician and an ecologist — the answer bristles with unconventional systems and nonlinear logic. They get right down to fundamentals. Instability is a result of our values. Were one of the team of authors a student of literature, the problem might have been likened to the macabre wish to "live fast, die young, and have a pretty corpse" that grew out of Nick Romano's unstable psychic structure in *Knock on Any Door.*

Books that treat the global population-pollution-power dilemma usually prefer to leave values out of the picture, presumably for the sake of objectivity. Then they predicate solutions on value changes in a final chapter that gushes with hope for humanity. *The Unsteady State* adopts a different strategy. It opens with 18 damaging beliefs and their remedial alternatives, and maintains that current socio-economic values are skewed because the economic system has been divorced from the ecological system that supports it.

A set of values is not the only victim of the divorce. Sound management principles derived from the natural order were replaced by the economic theory of the 19th century. The authors draw blood from the guiding hand of traditional economic theory by using ecological principles to identify the cause of instability.

### Economies of Scale

One measure of the efficiency of a biological system is the rate of energy flow through the system divided by its biomass. This efficiency in turn is negatively correlated to the diversity or variety of the system, which preserves its overall stability. When the authors apply this principle of ecology to the economy the result is: "Increasingly, economic power, both nationally and internationally, because of efficiency through economies of scale, is tending to be concentrated in a relatively small number of giant corporations. The consequence is just what we would expect from ecological theory: increasing tendency towards wide-amplitude fluctuations." By allowing the short-term values of efficiency that are embodied in the incentives of the market to operate in the absence of longer-term values which optimize stability, the socio-economy progressively becomes more vulnerable through lack of diversity, resulting in an unsteady state.

Many of the book's attacks on conventional wisdom are supported by data. One of the basic tenets of current economic and energy policy is that by increasing energy consumption, GNP increases. This occurs only up to point, say the authors. At about 5,400 lbs. of coal equivalents, further increases in energy consumption per capita correlate with a decrease in rate of growth in economic product per capita.

One of the most staunch positions for cheap energy heard in the halls of Congress and industry is that it is needed to create jobs. The authors maintain that high wage rates relative to low energy costs will be translated gradually into structural unemployment and higher crime rates when the effects of automation induced by cheap energy are felt. In the fashion of a closing circle, cheap energy, expensive labor, and automation — some of the heralded superstars of modern economic performance — are observed to contribute to pollution, rapid resource depletion, crime, and even high suicide and homicide rates.

### Energy and Revolution

There is a minority view of history, a theory of energy and social structure, with which *The Unsteady State* flirts. This view, embraced by University of Miami sociologist W. Fred Cottrell, University of Florida marine biologist Howard Odum, and Leslie White, an American anthropologist now deceased, sees energy as the organizing principle around which social scale, institutions, and values are created and destroyed. This theory agrees with the Toynbeeian patterns of genesis, growth, breakdown, and disintegration, but establishes a different line of causality and admits to the possibility of a long period of equilibrium after the growth period. The tools and technologies of a society are determined by the energy sources that society exploits. Social structure — i.e., institutions, customs and values — is derived from the way people organize around the technologies they use to produce the goods and services upon which their survival and well-being depend. To the extent that the energy source and technologies change, social structure changes. A major energy source change, which causes a vast retooling of a society's technological structure, is tantamount to a social revolution.

### Solar vs. Fossil Fuel Societies

Many of the problems of the unsteady state can be seen as the consequence of introducing fossil fuels into societies that were physically and socially organized around solar energy sources; they reflect the struggle that ensues at all levels when one culture takes over another. The relatively small amount of energy per capita afforded by solar sources tends to keep the economy dependent on local resources and markets, and the low level of energy input does not allow the social hierarchy to grow beyond the individual, the family, and local institutions. The relatively simple structure and close proximity between the highest and lowest levels of hierarchy tend to make human values a consideration of decisionmaking at all levels, and keeps the purpose of social organization focused on human needs.

The deep cultural clash between societies dependent on solar energy and those dependent on fossil fuel, both within and between nations, forms the underpinning of the major micro- and macro-physical and social changes of the last century. The quantum jumps of energy availability that fossil fuels have provided have resulted in an explosion of population, GNP, and expectations, both human and institutional. Capital increasingly displaced labor in

production. The resource base for economic activity shifted from renewable to nonrenewable resources. Production and consumption became organized on an international scale. The increasing amount of materials through Put threatened the stability of ecosystems. The primary role of the individual in economic activities shifted from production to consumption, with the assistance of consumer credit, advertising, and commercial television in the home. The family was structurally weakened as the basic unit of society when production, one of the Solar family's primary functions, was removed from the household. Many family and neighborhood functions such as education and care for the young, the old, the infirm, and the unemployed were shifted to larger institutions and government. All of these changes did not follow a pre-arranged design. They occurred as the social aftermath of a changing energy and technological structure in order to reap the benefits of greater energy input. In the process, social stability was traded for wealth.

Some of the physical and social weaknesses, even fatal flaws, of the Fossil-Fuel Society are just now emerging, and are outlined in *The Unsteady State*. Fossil-Fuel Society is physically unsustainable. It is based on non-renewable resources, many of which are now showing signs of global depletion. And the scale of its operations surpasses the materials-generating and waste-disposal capabilities of the ecological system on which all life depends. At the social level, the legitimacy of Fossil-Fuel Society's organization is being questioned.

Fossil-Fuel Society needs institutions much larger than those of Solar Society to manage and control the vast amount of energy flowing through it. It superimposed a macro-structure of large organizations of production, governance, education, finance, and marketing on the micro-structure of solar organization: individuals, the family, and local organizations. It severed the mechanisms of social control and the functional and geographical unity of small-scale social organization by making people and localities dependent on the products, wages, and institutions of national economies. Little by little, economic and political power shifted away from individuals and gravitated to corporations and government. The operational focus of social organization shifted from human needs to the needs of the large-scale institutions that arose to govern society.

### Value Change and Equilibrium

Eventually, the problem of equilibrium between energy, resources, population, and standard of living must be faced by all societies that seek long-term survival. By supplementing the solar energy input, fossil fuels expanded the resource base beyond solar energy levels and pushed off the question of equilibrium to some distant future. Just at the time when the peak of fossil fuel production is in sight, other physical and social limits to growth are appearing. The critical task becomes goal-setting, the homeostatic mechanism of the socioeconomy. In some natural systems like the human body, the goal-switching mechanism from growth to equilibrium is locked into genetic structure. In social systems it is a function of political wisdom and social values.

The values proposed in *The Unsteady State* are not new. They grow out of a system that depends on solar energy, where the connections between the ecological and economic systems are tightly woven and obvious. If these values are to become widespread again, it will not be because they are superior to other values. It will be because they are the most functional in the socioeconomy of the future.

*The Unsteady State* grapples with how to avoid a debacle that is more sensed than understood. Its worth lies more in its expanded view than in its numerical accuracy. It is too bad that the authors did not make actual simulation models based on the interesting flow diagrams in the text. Fortunately, though, the authors have resisted the new drift of naive thinking about macro-problems in which some form of socialism or communism is proposed to solve problems that both industrialized capitalist and communist countries share.

Those who believe that the world is proceeding from disorder to order should not bother reading *The Unsteady State* unless they take pleasure in being aggravated. The book will be a red flag to traditional economists, and those who champion statistical procedures as the purest form of revealing truth. Reductionists will label it bad science, and systems people will say it is a step in the right direction. It will appeal to number crunchers, value freaks, those who can build up a moral head of steam about profligate waste. For those who are concerned, even frightened, about society's inability to reduce the rate of resource depletion, pollution, unemployment, and crime, it opens some light at the end of the tunnel. Those who, like Carl Sandburg, believe in more than they can ever prove, will probably delight in the book's departure from reductionism and attempt at fashioning the tools of synthesis. The authors, while not turning over new theoretical ground, have not been timid about stepping into the center of the next century's destiny with admittedly inadequate tools.

*Charles Ryan has been Executive Director of the Systems Dynamics Group at M.I.T. He is currently teaching in the Department of Engineering and Economic Systems at Stanford University.* □

# How's Your Calculus?

*Allan Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Mathematics at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.*

As a new volume begins, let me review the ground rules of "Puzzle Corner" for new readers.

Each issue we publish five regular problems and two "speed" problems. Three issues later the solutions to the regular problems appear. This month, for example, we are printing the solutions to problems published last May. Challenges to published solutions and acknowledgement of late responses appear in the "Better Late Than Never" department. The "speed" problems are not to be taken too seriously. Often whimsical, their solutions are usually given the same issue as the problem is posed, and they rarely appear in the "Better Late Than Never" department.

Here is some news from our readers:

I remember that during my senior year at M.I.T., many of the graduating seniors were considering their chances for acceptance at various graduate schools. One of my friends, Mike Rolle, decided to enhance his chances by solving the famous four-color conjecture. Since generations of mathematicians had failed in this attempt, we didn't feel that Mike had much hope of success; but he was serious. During that year he actually obtained some impressive partial results, but the conjecture was still unsettled. The end of this story occurred this year after Appel and Haken finally solved the problem. I was reading their important papers in the *Illinois Journal of Mathematics* and noticed an acknowledgement to one Michael Rolle for his help. Congratulations, Mike; he who laughs last . . .

Congratulations, too, to Frank Rubin: the *Journal of Recreational Mathematics* will have a special Frank Rubin issue next April. . . . Dale Overy (27 Bodmin Avenue, Stafford Staffs ST17 OEF, England) has started a newsletter called *Puzzle World* devoted to mechanical puzzles.

Judith Longyear has suggested an informal poll of our readers to see which kinds of problems (chess, bridge, geometry, cryptarithmetic, etc.) are most (and least) appreciated. You are all welcome to respond, and significant preferences will effect future problem selections.

Several readers noted an error in the published solution to NS9. That problem is now reopened.

### Problems

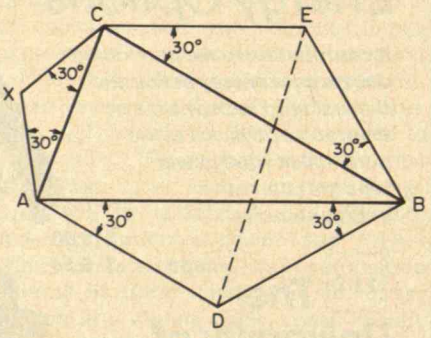
**OCT 1** William Butler wonders how normal is normal (in bridge, at least): Conventional point counting gives four points for each ace, three per king, two per queen, and one per jack. The average bridge hand has ten such points. What is the probability of receiving a hand with exactly ten points?

**OCT 2** Sebastian Batac would like to find two positive rational numbers the sum of whose cubes is 6. In other words, find positive integers a, b, c, and d satisfying $(a/b)^3 + (c/d)^3 = 6$.

**OCT 3** The following cryptarithmetic problem from Avi Ornstein consists of two mathematical statements which are correct in base 10 when digits are substituted for letters and is also true as read for modulo 9 mathematics:

SIX + TWO + TWO = ONE
SIX + SIX = TWO + ONE

**OCT 4** J. Friedman sends me a number of problems published by Calibrom Products as advertising in *Technology Review;* this one appeared in 1938:




Starting with *any* triangle, construct three exterior triangles having base angles of 30° and vertices at D, E, and X — as indicated in the diagram. If the distance DE is taken as 100, what is the distance DX? (The answer is a definite number, not a formula.)

**OCT 5** How's your calculus? Harvey Elentuck asks for the area of the loop of $Y^2 = (X + 4)(X^2 - X + 2Y - 4)$.
A noncalculus solution to this would be very impressive, but calculus is permitted.

### Speed Department

**OCT SD 1** Ruth Duffy asks us to name a word in the English language with seven letters, five of which are the vowels a, e, i, o, and u (but not necessarily in alphabetical order).

**OCT SD 2** The Editor of the *Review* discovered the following problem being distributed as part of a tongue-in-cheek "quiz" prepared by M.I.T. students for exhibitors in the 1978 Massachusetts Science Fair:
Translate into a limerick:

$(12 + 144 + 20 + 3\sqrt{4})/7 + 5 \times 11 = 9^2 + 0.$

### Solutions

**NS 10** (This was first published as 1974 **M/A 2** and never solved; it was published again as **NS 10** in February, 1978:
Find a closed form for

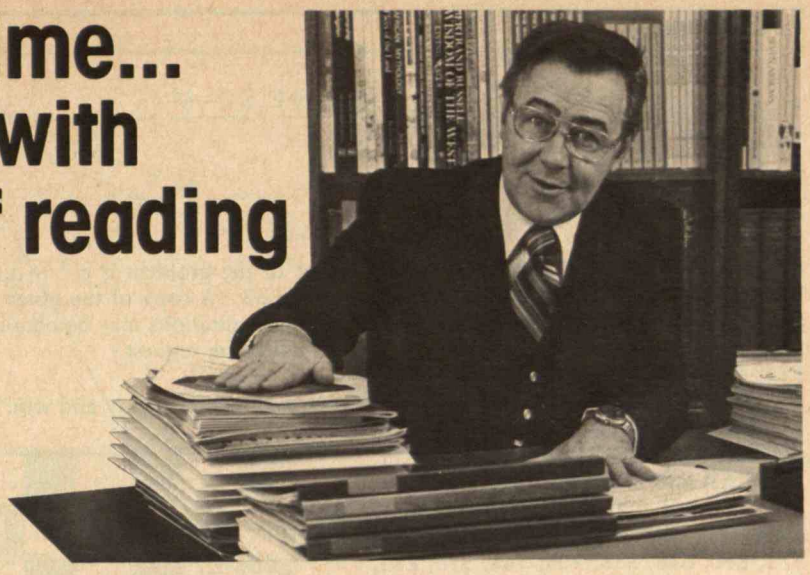
$1^1 + 2^2 + \ldots + n^n$.

When this was first published Leo Epstein supplied some asymptotic formulas. He has improved these, but we still have no exact closed form. Perhaps none exists.

**NS 12** A standard deck of 52 cards is shuffled and placed face down upon the table. The cards are then turned face up one at a time by flipping over the top card of the face-down stack. As this is done, the player simultaneously calls out the sequence A, 2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A, 2, etc., one call being made for each card flipped over. To win the game, one must go through the deck without matching a card flipped over with the card called. Suits don't matter, so, for example, any 4-spot flipped over on the 4th, 17th, 30th, or 43rd turn results in a loss. "Since winter will surely come again," Mr. Connine would like to know what are the chances of winning the game. How about a second solution for the same game with a 48-card pinochle deck?

This problem is not trivial! Judith Longyear gave a colloquium talk on her results in 1974. The answer is not $(12/13)^{52}$. Although the probability of success for any one card is 12/13, the events are

# "...for the first time... I'm keeping up with the mountain of reading I must do..."



A typical remark from one of the more than 100,000 people who have completed this amazing and satisfying course . . ."

If you are serious about keeping up with the reading you must do and want to do, then here's help! This accredited reading course is designed for people like you.

You can now approach 100% reading efficiency with speed plus comprehension with Speed Learning — much better than just speed reading!

All this at you own pace, in your own home and at one-fifth the cost of less effective programs.

Here is the help you have been looking for. SPEED LEARNING is a program that teaches you the advanced reading skills necessary for you to read faster with greater comprehension, increased retention or memory and increased enjoyment.

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*not* independent. Bob Kimble and an unnamed computer assert that of the 52! possible decks exactly 1, 309, 302, 175, 551, 177, 162, 931, 045, 000, 259, 922, 525, 308, 763, 433, 362, 019, 257, 020, 678, 406, 144 are winners.

They also solved the pinochle problem: of the 48! decks 2, 173, 013, 719, 746, 911, 580, 113, 686, 677, 997, 894, 282, 336, 936, 761, 753, 600, 000, 000 are winners. Since 52! = 80, 658, 175, 170, 943, 878, 571, 660, 636, 856, 403, 766, 975, 289, 505, 440, 883, 277, 824, 000, 000, 000, 000, they obtain a success probability of about 1.62 per cent.

Stephen Flaum and a TI 58 used an iterative technique:

At each iteration the probability of losing on that iteration is calculated. In addition, the expected number of cards remaining with each face value after the iteration, conditional on the assumption that the game is not lost on that iteration, is calculated. These expected values are used in subsequent calculations of the probability of failure.

This method requires fractions to be kept throughout. Flaum and TI actually divide out the fraction and use the approximating decimal. Perhaps this explains their answer of 1.77 and .0225 percent for pinochle.

A. Walther claims the answer is:

$$\left(\sum_{P=0}^{13}(-1)^P \cdot 1/P!\right)^4$$

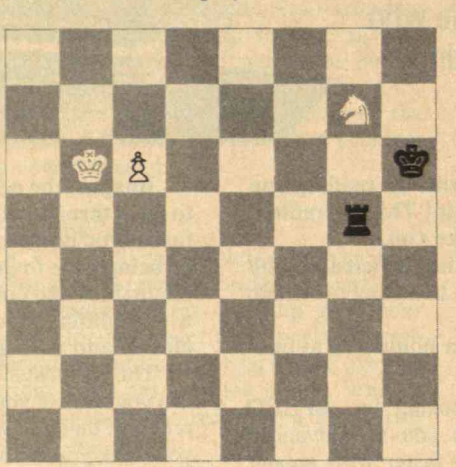
or approximately $e^{-4}$ (i.e., over 1.8 per cent). His remarks follow:

Make on the table an array 13 blocks long and four blocks wide. Label the four rows with the names of the four suits. Turn the cards over, one at a time, and place them in the array, going from left to right and placing each card in the row matching its suit. After we have gone through the entire deck, we have on the table four rows of 13 cards, one for each suit in the deck. To win the game no card must be in its proper place — i.e., each row of 13 cards must be a "complete permutation." A complete permutation is defined as a permutation in which none of the elements is in its proper place. The theory of complete permutations is developed on some sheets saved for me by E. L. O'Neill which you may want to share with interested readers. The ratio of the number of complete permutations to the total number of permutations for m elements is

$$\sum_{p=0}^{m}(-1)^P 1/P!$$

This is very nearly $e^{-1}$; therefore, the answer to the problem is $e^{-4}$ — i.e., about one in 53. (A copy of the notes on complete permutations may be obtained from the editor on request.)

MAY 1 White to play and win:



Several readers slipped up on this one. By playing 2K — B5 they allow a neat draw:

| | |
|---|---|
| 2. . . . | R — N8 |
| 3. 3P — B8 (Q) | R — B8 ch |

Joseph Seo, however, avoids this and finds a solution with only one line:

| | |
|---|---|
| 1. P — B7 | R — N3 ch |
| 2. K — N5 | R — N4 ch |
| 3. K — N4 | R — N5 ch |
| 4. K — N3 | R — N6 ch |
| 5. K — B2 | R — N7 ch |
| 6. K — Q3 | R — N6 ch |
| 7. K — Q4 | R — N5 ch |
| 8. K — Q5 | R — N4 ch |
| 9. K — Q6 | R — N3 ch |
| 10. N — K6 | R — N1 |
| 11. N — Q8 | R — N3 ch |
| 12. K — K7 | R — N2 ch |
| 13. N — B7 ch | K — any |
| 14. P — B8 (Q) | Resigns |

Responses also received from Bob Kimble, William Butler, Rufus Franklin, Cary Silverston, Robert Bart, Smith Turner, Jerome Taylor, Winthrop Leeds, Roger and Paul Milkman, Jacob Bermann, T. Mahon, Darryl Hartman, Richard Kandziolka, Richard Hess, Walther Fischer, and Harry Nelson.

MAY 2 "Dentification" and "identification" are both English words. For each English letter $\alpha$, what is the longest string $\beta$ such that both $\beta$ and $\alpha\beta$ (the concatenation of $\alpha$ followed by $\beta$) are English words? Pairs such as "allelujah" and "hallelujah" or "enanthaldehyde" and "oenanthaldehyde" are excluded, since they are simply variant spellings or variant pronunciations of the same word.

Dennis Kluk submitted a list which will be hard to beat. (I must add that some of his words are not in my vocabulary; perhaps I should have specified a (small) dictionary in which all words were required to appear.) Mr. Kluk's list, which follows, comes from *Word Ways,* subtitled the journal of recreational linguistics: **Aquintocubitalism, Blithesomeness, Chemotherapeutics, Demulsification(s), Emotionlessness, Frightfulness, Gastrophotographics, Hedriophthalmous, Identification(s), Japaconitine, Kineasthetic, Limitableness, Methylhydrocupreine, Neopaleozoic, Oesophagostenosis, Premosrepresentation(s), Quinta(s), Revolutionally, Selectiveness, Treasonableness, Utopographer(s), Vindictiveness, Whenceforward, Xanthosiderite, Yourselves, and Zoosporiferous.**

Also solved by Harry Hazard, Jacob Bermann, Emmet Duffy, Paul Hertz, and the proposer, Donald Forman.

MAY 3 Given an n-by-n checkerboard and $n^2$ checkers of n different colors, and given that there are n checkers of each color, is it possible to arrange all the $n^2$ checkers on the board such that no two checkers of the same color lie in the same row, column, or diagonal? (By "diagonal" is meant *all* the diagonals, not just the two main diagonals.) It turns out that for certain values of n it is possible to so arrange the checkers; in this case we say a solution exists — e.g., n = 1. But for certain other values of n such an arrangement is impossible — i.e., no solution exists. For which values of n does a solution exist?

For some unknown reason, I published this problem twice: once as FEB 3 and now again as MAY 3. More surprising than this is the fact that no reader noticed my error; as soon as I saw the May issue I made ready for the slings and arrows. The responses to MAY 3 are consistent with the published solution to FEB 3 (see *June/July, page* 27). In short, an algorithm exists for N = 6K ± 1 (i.e., N not divisible by 2 or 3), and several readers assert (without proof) that no solution exists for the remaining cases. I repeat my comment of June/July: this looks like an NS problem for the 1980s.

Responses received from Judith Longyear, William Butler, T. Mahon, Ari Ornstein, Richard Hess, Bob Leisy, and the proposer, Sheldon Razin.

MAY 4 Assign numerical values to each letter:

```
          HEN
AARON)PHARAOH
      AARON
      -----
       OOYPO
       BBNYZ
       -----
       AEYDNH
       ACEPHH
       ------
        ERPZC
```

This is a base-12 cryptarithmetic problem, and those solving it were reminded that duodecimal notation has two extra digits following 9 before reading the radix. For uniformity, these were specified to be "dek" (symbol X, numerical value equals decimal 10) and "el" (symbol ϵ, numerical value equals decimal 11). Then the radix is "dozen," or "do" for short.

Cryptarithmetic problems tend to be popular, and this one, with its base-12 twist, was no exception. Several readers asked for more such problems; the best way to achieve this is to send more in. The following solution is from Shirley Wilson:

```
          12ϵ
3359ϵ)4135391
      3359ϵ
      -----
       99749
       66ϵ7x
       -----
       3278ϵ1
       302411
       ------
        254x0
```

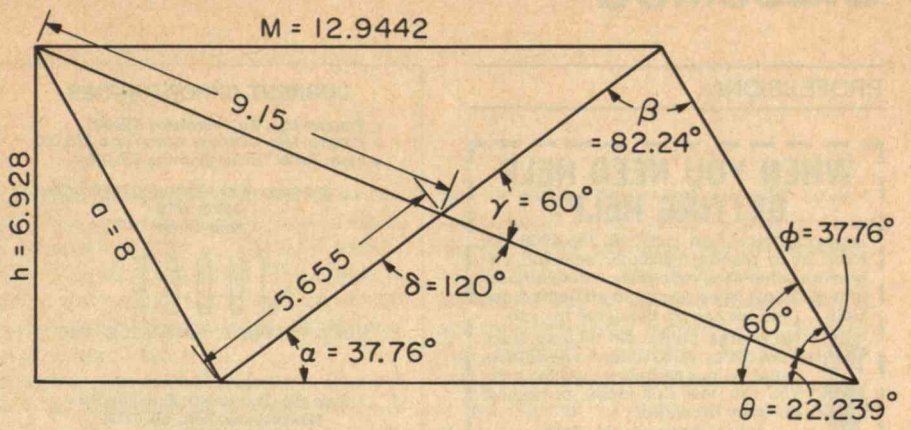
1. H = 1
2. C = 0
3. A − N = P or 10 (do) + A − N = P, but P = A + 1, so 10 + A − N = P and hence N = ϵ
4. Z = x
5. O = 9
6. Since A − R = 9 or 10 + A − R = 9, and since A ≠ x and A ≠ ϵ, 10 + A − R = 9 and hence 10 + H − 1 − A = 9. Therefore, A = 3 and R = 5.
7. P = 4, E = A − 1 = 2, D = 8, Y = 7, and B = 6.

Thus, as many readers noticed, the substitutions are:

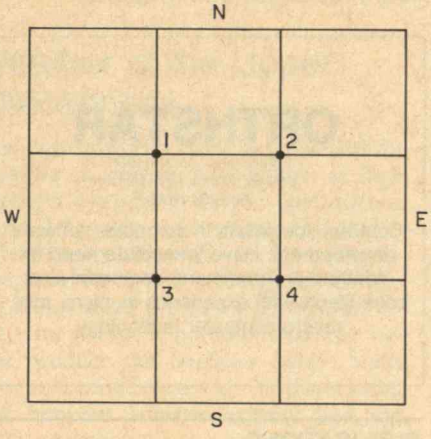
0 1 2 3 4 5 6 7 8 9 X ϵ

C H E A P R B Y D O Z N

Also solved by: Rona Rybstein, Bob Kimble, William Butler, Robert Slater, Paul Hertz, Christopher Roth, Robert Bart, George Demetriou, Dennis Sandow, Naomi Markovitz, Timothy Maloney, Dermott Breault, Jon Thaler, Curtis Brown, Harry Zaremba, Douglas Szper, Harry Hazard, Winslow Hartford, Gerald Blum, T. Mahon, Avi Ornstein, Jacob Bergmann, Lisa Chabot, Mike Bercher, Richard Hess, Michael Froman, Judith Longyear, and the proposer, William Schumacher.




MAY 5 A dog is lost in a square maze of corridors. At each intersection, he chooses a direction at random and proceeds to the next intersection or exits at one of the sides. His walk is over when he reaches one of the sides. What is the probability $P_k$ that the dog, starting at intersection k, will exit at the south side?




The following solution is from Vic Elias, who was a graduate student in physics at Santa Cruz the year I taught mathematics there. His solution seems to me to look like a physicist's; he finds an extra symmetry most people miss. Of course, they solve the problem anyway, but that's beside the point. He writes:

The symmetry of the problem requires that $P_1 = P_2$, $P_3 = P_4$, and $(P_1 + P_2 + P_3 + P_4)/4 = 1/4$. [This last relation is equivalent to saying that if the dog is equally likely to be at any of the four intersections, his probability of exiting the maze in any given direction is 1/4]. Thus

$$2P_1 + 2P_3 = 1 \qquad (1)$$

Suppose the dog is at intersection 1. By letting it move one unit from intersection 1, we see that $P_1 = P_2/4 + P_3/4$, in which case

$$3P_1 = P_3. \qquad (2)$$

Combining (1) and (2),

$P_1 = P_2 = 1/8$ and

$$P_3 = P_4 = 3/8. \qquad (3)$$

As a check, let the dog start at intersection 3. Then

$$P_3 = P_1/4 + P_4/4 + 1/4. \qquad (4)$$

The relations (3) are consistent with (4).

Also solved by Bob Kimble, John Pierce, Jeff McGuire, Steve Rosenberg, William Butler, Smith Turner, Paul Hertz, Peter McMenamin, Robert Bart, Jon Thaler, Winslow Hartford, Harry Zaremba, James Tanenbaum, Gerald Blum, Douglas Szper, Frank Carbin, T. Mahon, Richard Hess, Marshall Fritz, Rodney Weatherford, Judith Longyear, and the proposer, John Prussing.

1977 DEC 5 Irving Hopkins is not happy with Raymond Kinsey's solution. Mr. Hopkins' comments follow the drawing (see above) which shows his solution:

From my solution, given $(\theta + \phi) = 60°$,
$K = M/a = \cos 60° + (\cos^2 60° + 1)^{\frac{1}{2}}$
$= 1.618034$
Given $a = 8$, $M = 12.9442$
$h = a(\sin 60°) = 6.928$
$\theta = \arctan(6.928/16.9442) = 22.2390°$
$\phi = 60° - \theta = 33.76°$
$\delta = 120°$
$\gamma = 180° - 120° = 60°$
$\alpha = \arctan(h/(M - 4)) = 37.76°$
$\beta = 180° - 60° - \gamma = 82.24°$.
From this, $\alpha = \theta + \phi = 60°$
$\delta = \alpha = \beta = 120°$,
*not* $(\gamma) = (\alpha + \beta)$ and $(\delta) = (\theta + \phi)$
$(60) = (120)$ and $(120) = (60)$
Also, from the above, $\beta = 82.24$, and $\theta = 22.24$, whence $\beta$ cannot equal $\theta$, as Mr. Kinsley claims. Hence the rest of the argument falls apart. Also, if we consider the simultaneous equations R/S = M/L and 2R/L = M/S, we can eliminate R and M, with the result that $L^2 = 2S^2$, which is obviously not generally true. Or similarly, by eliminating L and S, we find $M^2 = 2R^2$, equally untenable.

**Proposer's Solutions to Speed Problems**

SD 1 Sequoia.

SD 2 (courtesy of AG): Twelve plus one forty four; plus twenty plus three roots of four; divided by seven; plus five times eleven; gives nine squared and not a bit more.

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## New England: Economic Underdog May Soon Emerge on Top

Reassuring word for New Englanders from economists at the Joint Center for Urban Studies of M.I.T. and Harvard: the New England economy — often described in direly pessimistic tones — is on the mend.

Professors John R. Meyer and Robert A. Leone see neither boom nor disaster; their crystal ball shows a period of stability and even modest, steady growth. Wages and other costs have now stabilized so that existing industries will feel less threatened in the future than in the past. With a long industrial history, New England has a large industrial infrastructure in place; in a time of rapidly inflating construction costs, this is an asset. There is also a rich supply of recyclable resources. New England's historical disadvantage — the high cost of fuel and electricity — is being eroded as prices rise faster (on a percentage basis) in other parts of the U.S. than here.

Indeed, say Professors Meyer and Leone, as other regions of the U.S. stabilize and mature they may look enviously on New Englanders who have already learned how to do so gracefully. □

## Moldy Bread and Cancer

The thought that a moldy slice of bread may be a carcinogen is staggering. But evidence is rapidly accumulating to suggest that food spoilage molds have to be taken seriously; some produce quite potent toxins.

During the middle ages, hallucinations and tremors were, of course, attributed to witchcraft rather than moldy bread.

But the real problem became apparent in the early 1960s when scientists in England, investigating the death of poultry from feeding on moldy peanut meal, discovered a new mold toxin, aflatoxin, which also turned out to be a potent liver carcinogen in test animals. Now many epidemiological studies suggest a correlation between the ingestion of contaminated foodstuffs and the occurrence of liver cancer, according to Professor Gerald N. Wogan of the Department of Nutrition and Food Science at M.I.T.

Why is aflatoxin a carginogen?

It is now a widely accepted hypothesis that carcinogens damage genetic material. And the toxicology group under Prof. Wogen has shown that aflatoxin does just that. Their research has now moved on to the question of how a variety of animal species "handle" this toxin. They hope to observe differences which will give clues to help identify critical stages in the process of cancer induction.

Another aspect of the group's research has to do with devising sensitive methods for detecting excreted aflatoxin endproducts. Richard A. Bennett, a graduate student in the M.I.T. Toxicology Laboratory, thinks the ability to detect endproducts in human urine would make possible warnings to patients that exposure to this carcinogen has occurred and that liver damage is possible. — *Brunhilde Kobbe* □

## Weather in the Upper Atmosphere

The most powerful radar in the world for studying the upper atmosphere at high northern latitudes is now in operation at M.I.T.'s Lincoln Laboratory. The goal is to learn more about the motion of the atmosphere 60 to 600 miles above the arctic; winds there are believed spawned by the same energetic particles from the sun that produce the northern lights. Some observers think these may be the missing link between sunspot activity and the earth's weather.

## Innovating Rockets on a Microscale

A propellant ignited in a rocket motor shoots its exhaust out the tail of its aircraft, thrusting the craft high into the air. At apogee the rocket releases a glider and then returns to earth on a parachute. It sounds and looks real, but it's all done in miniature; for this is no ordinary rocket: it's a model rocket, about two feet long, embodying ingenuity and a craftlike creativity.

A model rocket is a creation, not an assembly-line product. The rocketeers order paint, wood, and other parts from many catalogs. If eyeglass screws are not small enough, it may be necessary to sand down a tiny rivet and punch grooves in the top with the proper Exacto knife. There are even a couple of books on how to mix your own propellant. And countless ingenious ways to avoid the penalties of size and weight.

For example, how to be sure that the two or more engines on a model rocket fire at once? If they don't — that is, if an engine on one side fires, but the opposite engine doesn't — the flight will be at best off course and at worst a disaster. Years ago an enterprising modelbuilder realized that flashbulbs will fire simultaneously using just battery current, and their flash is hot enough to ignite an engine. Now model rocketeers use flashbulbs routinely, and rockets with as many as 35 engines have taken off using flashbulb ignition.

The rocket fitted with a glider is controversial because experimenters are now trying to use radio controls to prolong glider flights, thus adding skills in electronics to those in aerodynamics required to corral the prizes for staying in the air the longest. But what do you do to keep the glider in sight, to be recovered when it finally lands? More ingenuity: fit a remote control device which enables the operator to adjust the wings while the glider is in flight.

Model rocketeers are into theory as well, and differential equations — for example — are important in rocket theory. Acceleration can be measured as a function of thrust (including an accounting for the changing mass as the propellant is used up), gravity, and air drag. Iterative solutions predict the effects of streamlining to reduce air drag or changing rocket mass.

Countless practitioners prove that the appeal of model rocketry is the room for ingenuity with a lack of the cut-and-dried. — *Robert L. Virgile, '78* □

## What's Been Overlooked in Basic Energy

When you think of energy you think of oil, gas, coal, electricity, perhaps the sun, maybe the tides . . . of boilers, furnaces, reactors, collectors, turbines, and generators. Do we really know as much as we should about all these systems and devices? Are we missing some bets for the future because today's knowledge is inadequate?

Thomas F. Jones, M.I.T. Vice President for Research, says that physicists and engineers should be busy taking "a completely new look at all energy" processes "to see what's been overlooked in basic knowledge.

"We've never even really taken a complete cataloguing of what's there," Professor Jones told *Chronicle of Higher Education* in a Sun Day interview late last spring. "We need to go back and re-search in its truest sense," he said. □


# Can you identify the chemical engineer in this group?

**You're right if you said all of them.** And you're right again if you conclude that Kodak offers a wide choice of career paths for individuals with strong technical skills. So it shouldn't be a surprise that our top management team is predominantly individuals with engineering backgrounds. At Kodak plants in Windsor, Colo.; Rochester, N.Y.; Kingsport, Tenn.; and Longview, Tex., you'll find chemical engineers in hard hats performing vital production staff functions and others deeply involved in design and development. Other chemical engineers are more often in business suits, calling on customers all over the country as Technical Sales Representatives. And some don't stray too far away from the satisfactions they find in the research labs. Incidentally, it would be very easy to find this kind of occupational variety among mechanical, industrial, or electrical engineers at Kodak.

Some of the members of this group found a bachelor's degree was all that was needed to prepare them for a challenging job. Other positions are better suited for someone who has completed a master's degree. If you prefer to work now and study later, the Kodak Educational Aid Program offers opportunities for full- or part-time learning. Those bent on a career in research usually apply to us with Ph.D in hand.

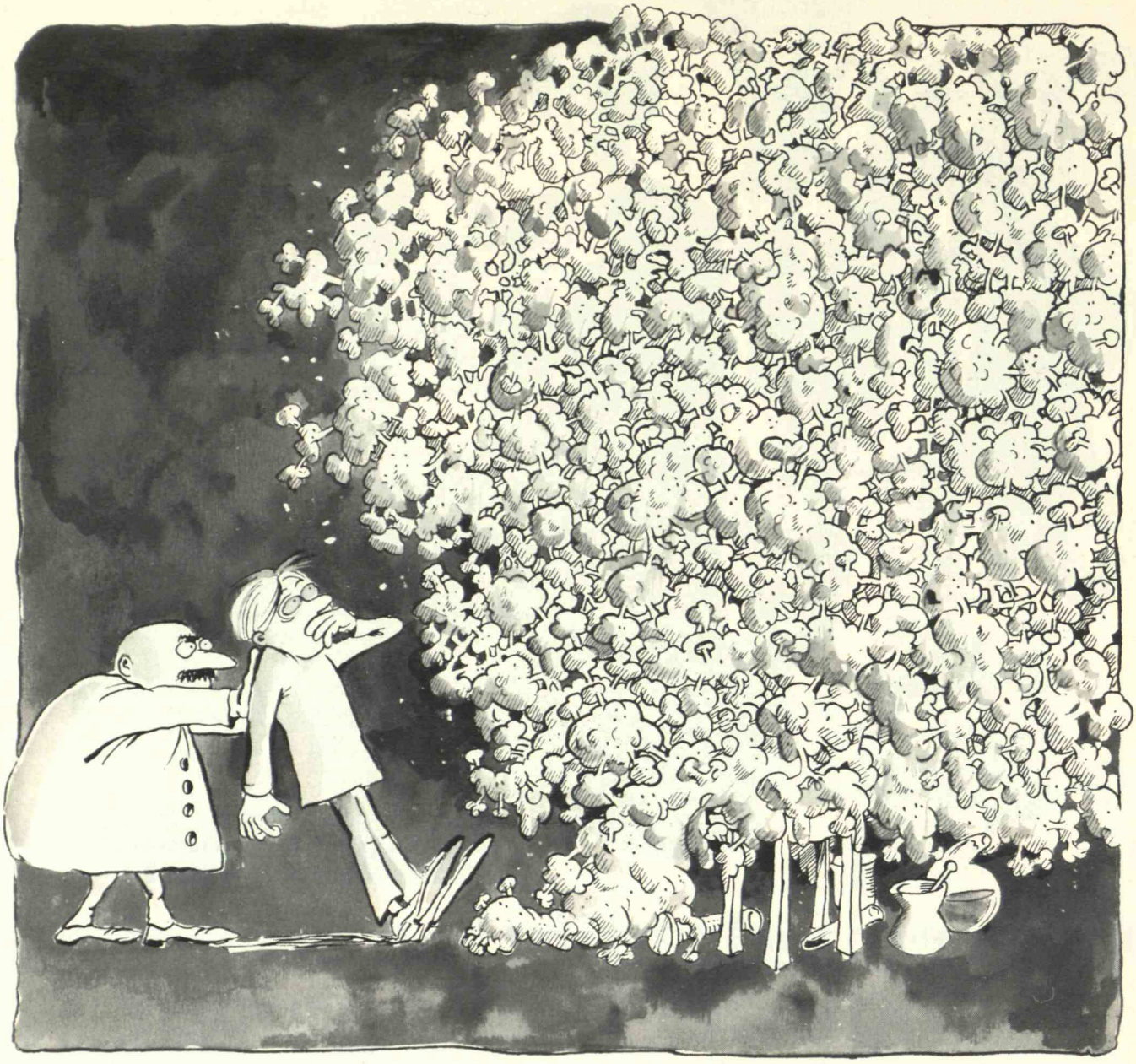
At Kodak, the emphasis is on technical innovation as a blueprint for keeping pace with our changing world. It's taken us—and it can take you—far from our photographic origins. For example, our basic expertise in photographic emulsion coating was the springboard to the development of a new clinical blood analysis system for health care. Our need for chemicals in photographic manufacturing led to the development of a multiplicity of products including fibers, textiles, and dyes for apparel and home furnishings. And our imaging abilities gave us an opportunity to make and market quality business equipment like microfilmers and copier-duplicators.

When a company is open to new directions, the people who work for it should expect changing horizons in their individual roles as well. Where the future can take you at Kodak depends on a lot of things—like personal preferences, performance on the job, and available openings. What we can promise is the opportunity to explore many conventional engineering choices plus a lot of other vital professional options.

Begin by contacting Business and Technical Personnel, Eastman Kodak Company, Rochester, N.Y. 14650.

Kodak

An equal-opportunity employer (f/m) manufacturing photographic products, fibers, plastics, and chemicals with plants in Rochester, N.Y.; Kingsport, Tenn.; Windsor, Colo.; Longview, Tex.; Columbia, S.C.; Batesville, Ark.; and sales offices throughout the U.S.A.



# At Celanese, we won't force you into a mold.

The challenge of being part of a large, growing corporation could be offset by the fear of being swallowed up, forced to conform to the company's way of thinking.

At Celanese, we didn't get to be successful by sticking to the traditional way of doing things. Our unusually open working environment, our flexible handling of responsibilities have won us a solid position in the production of chemicals, fibers, plastics and polymer specialties.

When you come to work at Celanese, you'll be assigned to a project right away. You can put your creativity and decision-making skills to good use. We won't waste your time in lengthy training programs – we won't waste your mind by forcing you to fit into a corporate mold. You'll have the freedom and the opportunity for rapid growth and advancement at Celanese.

We're looking for people who are still growing, and want to be part of an expanding industry. You just might fit in – your way – at Celanese.

If you have a degree in engineering or chemistry, ask your placement officer to set up an interview with us, or write Tom Clark, Celanese Building, 1211 Avenue of the Americas, New York, N.Y. 10036.

CELANESE®

An equal opportunity employer m/f

# Innovative self-destruction•Engines of change•An alternative to planned chaos

Capitalism—or democratic capitalism, or a system of free choice, or whatever you choose to call the U.S. economic system—is perhaps the most dynamic paradox around.

Like democracy, it is the worst system except for all the other systems mankind has tried.

Like mankind itself, it spends a lot of time on the ropes, but it always bounces back.

Because of the mixed economy that has resulted from government intervention, our system has been called "capitalism in an oxygen tent." But reports of its death are greatly exaggerated.

It survives by a process of innovative self-destruction. Which is to say, democratic capitalism compulsively develops new and better ways of doing things. Thus it makes obsolete the very practices that strengthened it in an earlier time.

This process is, by its very nature, endless. In a free society, mankind's entrepreneurial spirit tells him he has to improve on existing products and processes and procedures if he is to create a competitive edge for himself, or even just to meet competition. Thus is relentless improvement built into the system.

This perpetual change is one of the main reasons that what we loosely call capitalism is so hard to define. It is also the main reason that what passes for capitalism in some countries is such a far cry from the dynamic democratic capitalism to which we Americans are accustomed—imperfect but always trying to correct its imperfections. And always learning from experience, even when it learns the hard way.

The stern discipline that compels productive innovation is the requirement that a privately owned business earn a profit—i.e., that it meet a need and meet it efficiently enough to have something left over to meet tomorrow's needs. The system polices itself pretty well, overall; private businesses that cannot achieve the requisite efficiency usually go under.

In a state-controlled economy, you have just the opposite. Not being required to earn a profit, government businesses have little interest in holding down costs. They tend to develop a single objective: status quo and self-preservation at all costs. Those costs become increasingly higher as such organizations strive toward political, rather than economic, objectives.

Thus an essential difference between government and private businesses is the difference between rigidity and creativity. Economic systems run by government tend, by their doctrinal nature, to be static, because any departure from dogma is labeled heresy. This produces a static situation, but static socialism is still socialism.

Static capitalism, on the other hand, would be a contradiction in terms. Capitalism cheerfully occupies itself with a continuing confession of error as it labors to outdate yesterday's improvements. It tends to question the validity of all revealed wisdom that locks itself into any tight doctrine not supported by experience and common sense. It operates on the old Army doctrine that if you're comfortable, you're out of position.

Democratic capitalism is a form of institutionalized self-interest in which most large corporations have to serve a very large mass market if they are to survive and prosper. This makes them democrats of the marketplace, in contrast to those who seem to fear the decisions free people will make if left to their own devices.

Those who argue for a dominant role for government in our economy maintain that an economy that is not centrally planned and heavily regulated is necessarily chaotic. They don't seem to grasp that our system is a continuing revolution, and revolutions are almost invariably untidy. The bureaucrat's impulse is to try to neaten things up, which seldom serves the consumer's interest.

Capitalism, with all its imperfections and its driving ebullience, admittedly spends much of its life in an untidy state of cliff-hanging crisis—just as mankind always has. But indices used to measure the state of the U.S. economy indicate that the fabulous invalid has survived another bout of illness and, with proper nourishment and the right amount of constructive neglect, will pull through again. Which should be good news for all of us, especially for those still struggling to work their way out of poverty.



Mobil®

Box A, Mobil Oil Corporation, 150 East 42 Street, New York, N.Y. 10017

*"This is reclaimed land. The coal is out, and soon the sheep will be grazing here again."*

# "We need the land as much as we need the coal. We found a way to have both."

"For centuries, the Navajo have used this land for grazing their sheep," says Ben Sorrell, a Gulf Land Reclamation Supervisor. "Their whole livelihood depends on it, as it has for centuries.

## Riches below

"But this land is some of the best coal-producing country in America. So the Navajo nation, which owns the land, leased part of it to Gulf's subsidiary, The Pittsburg & Midway Coal Mining Co.

"Now it's one of P&M's most productive mines. It's producing three million tons of coal a year, and it's being expanded to five million.

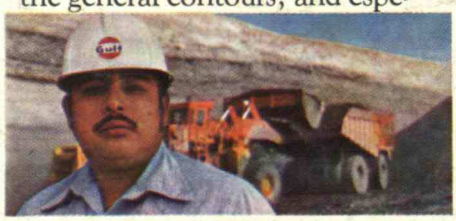
## Riches above

"It's my job to put things back pretty much the way they were before mining started.

"As much as possible, we try to restore the character of the land, the general contours, and especially the drainage patterns.

"When we're finished, it's as good grazing land as it ever was—sometimes better.

"It's a real challenge, getting out the coal we need, without destroying the land, which we need just as much. I'm a Navajo myself, and I'm proud of the way Gulf is meeting that challenge."



*"This is where I work: the McKinley Mine, near Gallup, New Mexico."*

Gulf Oil Corporation.

Gulf

**Gulf people: meeting the challenge.**